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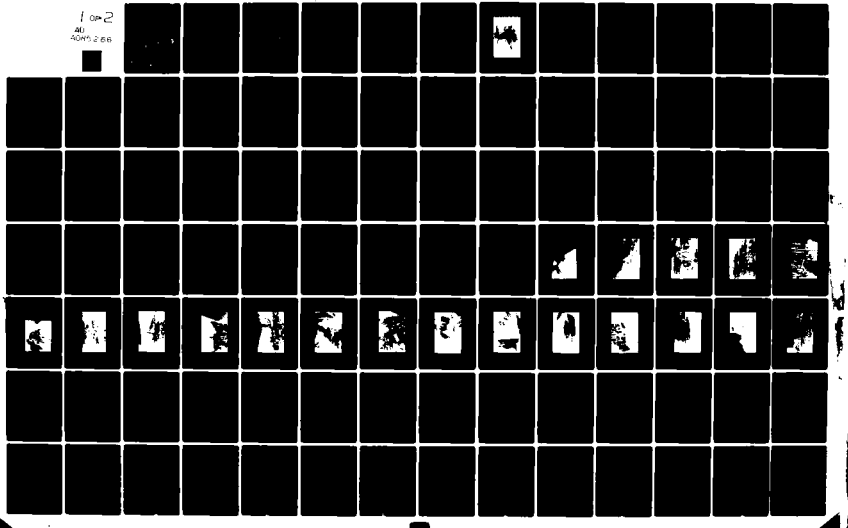

DELAWARE RIVER BASIN
TRIBUTARY TO MAIDEN CREEK
BERKS COUNTY
PENNSYLVANIA
NDS ID PA. 00721
DER ID 6-460

CHRISTMAN DAM

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

WOODWARD-CLYDE CONSULTANTS

DACW31-80-C-0018

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

MARCH 1980

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DELAWARE RIVER BASIN

TRIBUTARY TO MAIDEN CREEK

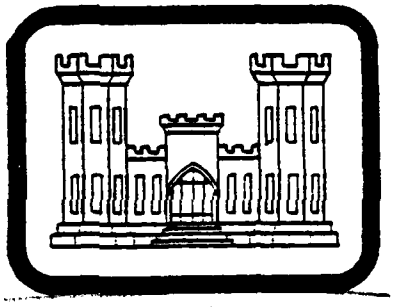
CHRISTMAN DAM

~~BERKS COUNTY, PENNSYLVANIA~~

(NDS I.D. ~~NO.~~ PA ~~00~~721
DER I.D. ~~NO.~~ 6-460), Delaware River

Tributary to Maiden Creek, Berks County,

Pennsylvania. PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM



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Prepared by:

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5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

G. Mayfield · Jno Henry/Frederick, Jr

Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

March 1980

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to expeditiously identify those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Christman Dam
County Located:	Berks County
State Located:	Pennsylvania
Stream:	Tributary to Maiden Creek
Coordinates:	Latitude 40° 32.5'
	Longitude 75° 53.2'
Date of Inspection:	November 21, 1979

Christman Dam is owned and maintained by Mr. Carl W. Christman. The dam was built for recreational purposes.

Visual inspection and review of design documentation indicate that the spillway is in fair condition, but the overall evaluation of Christman Dam is poor. The dam is classified as a "Small" size structure with a "High" hazard classification, consistent with its potential in the event of failure, for extensive property damage and loss of life in the downstream town of Virginville.

In accordance with criteria established by Federal (OCE) Guidelines, the spillway design flood is 0.5 to 1.0 PMF (Probable Maximum Flood). As the height of this dam is near the lower limit for small size dams, and the existing total capacity is about one-third of the upper limit, the selected spillway design flood is 0.5 PMF. Hydrologic and hydraulic computations presented in Appendix D indicate that, under existing conditions, the spillway can pass about 0.59 PMF without overtopping the embankment. Under design conditions, the spillway can pass about 0.88 PMF without overtopping. Therefore, the spillway system of this structure is considered to be "Adequate".

It is recommended that the following measures be undertaken immediately under the supervision of a registered professional engineer experienced in the design and construction of dams.

(1) The embankment stability analysis requested by the state should be performed, using constructed slope angles and as-built soil parameters obtained from undisturbed samples.

(2) The crest elevation should be increased to meet the design elevation.

(3) The trees and root masses should be completely removed and the slope restored to its original condition. All woody vegetation should be cut on an annual basis.

(4) Additional backfill should be placed behind the spillway chute walls.

(5) The riprap partially blocking the weir should be removed.

(6) The hose through the embankment should be removed and the embankment returned to its original condition.

(7) Provide a method of upstream closure of the pond drain conduit.

Because of the location of the dam and the potential for heavy property damage and possible loss of life in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents if high flows are expected and provisions for evacuating these people in the event of an emergency. In addition, the Owner's engineer should develop a detailed maintenance and operation procedure to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

Mary F. Beck — 3/18/80

Mary R. Beck, P.E. — Date
Pennsylvania Registration 27474-E
Woodward-Clyde Consultants

3/18/80

John H. Frederick, Jr., P.E. — Date
Maryland Registration 7301
Woodward-Clyde Consultants

APPROVED BY:

25 APR 80

JAMES W. PECK — Date
Colonel, Corps of Engineers
District Engineer

OVERVIEW
CHRISTMAN DAM, WINSOR TOWNSHIP, BERKS COUNTY, PENNSYLVANIA

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
CHRISTMAN DAM
NATIONAL ID NO. PA 00721
DER NO. 6-460

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Christman Dam is a zoned earth dam about 27 feet high and 630 feet long, constructed over a cutoff trench under the dam centerline. The relatively impervious core and cutoff trench reportedly consist of clayey silt with decomposed stone fragments, and the pervious shell of shale rock with clayey silt binder. The cutoff trench is ten feet wide at the bottom, and the side slopes of the trench and core are 1H:1V. The main portion of the embankment is 400 feet long with a design crest width of 18 feet, and upstream and downstream (design) slopes of 2.5H:1V. The design drawings indicate that the shorter leg of the embankment, with a 14 foot maximum height, makes an angle of 137.5 degrees with the maximum section, has a six foot top width, and upstream and downstream slopes of 2H:1V. The dam was constructed to have an approximately constant top width the entire length, however. The entire upstream slope of the dam is shown to be protected with riprap placed on a 12 inch thick filter blanket. The crest is paved with gravel; the downstream slope is protected with vegetation. The entire length of the crest serves as an access road to homes on the right side of the reservoir.

A side entrance spillway is at the right end of the embankment. A 100 foot long weir makes an angle of about 90 degrees with the dam centerline. The weir discharges into a trough about 15 feet deep and 10 feet wide at the back to 15 feet wide at the front. Discharge flows under a bridge at the

dam centerline and then down a concrete chute to the natural channel about 135 feet beyond the dam centerline. A 24 inch prestressed concrete cylinder pipe pond drain conduit is located about 72 feet from the left side of the bridge over the spillway. The intake is at the upstream toe and completely under water, and the conduit discharges at the downstream toe, as shown in Photograph 3, Appendix C. Discharge through the pond drain is controlled by a cast iron sluice gate at the downstream end. There are three anti-seep collars around the pond drain conduit.

Embankment seepage is controlled by a rock toe at the downstream edge. Plan and cross-section views of the dam and spillway systems are included in Appendix E.

b. Location. The dam is located across an unnamed tributary to Maiden Creek in Windsor Township, Berks County, Pennsylvania. The dam site is located approximately one mile north of Virginville, Pennsylvania. The dam site and reservoir are located on the USGS Quadrangle map entitled, "Hamburg, Pennsylvania", at coordinates N 40° 32.5' W 75° 53.2'. A regional location plan of Christman Dam and reservoir is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as a "Small" size structure by virtue of its 27 foot height and total capacity of 322 acre-feet under existing conditions.

d. Hazard Classification. A "High" hazard classification is assigned consistent with the dam's location above a small residential area and the potential to cause extensive property damage and loss of life downstream of the dam along Maiden Creek in Virginville.

e. Ownership. Christman Dam is owned by Mr. Carl W. Christman. All correspondence should be sent to Mr. Carl W. Christman, Christman Road, RD #1, Post Office Box 118, Lenhartsville, Pennsylvania 19534.

f. Purpose of Dam. The dam was built for recreational purposes.

g. Design and Construction History. On September 26, 1967, an application was made for a permit to construct a dam across the tributary to Maiden Creek. At the time the application for a permit was made, completed plans for the dam were also submitted. CVM Industries, Test Boring Division, made test borings at the site, and Ambric Testing & Engineering Associates had obtained samples and performed sieve analyses, liquid limits, compaction and direct shear testing of the soil samples. Several changes were requested by the state and were made to the design. On January 12, 1968, the

"Report Upon the Application of Carl W. Christman" was made by the state, and a permit was issued on March 13, 1968. General Consultants, Inc. was retained by the Owner, who was also acting as the contractor, to supervise and inspect the construction of the dam, and a preconstruction meeting between the Owner, engineer and state representatives was held at the site on May 15, 1968. Additional test pits were dug in prospective borrow areas, and materials were forwarded to Allentown Testing Laboratories, Inc., for analysis. Allentown Testing also provided in-place compaction testing. A portion of the cutoff trench was inspected by a state representative on June 26, and found to be acceptable. In-place density tests in July indicated that compaction results were well below the specified 100 percent (AASHO T-99). General Consultants directed Mr. Christman in July 1968 to increase compactive effort and soil moisture in order to obtain the required densities. On November 11, 1968, a progress report submitted to the state indicated that the spillway bridge walls were 95 percent complete, the bridge 80 percent complete, earthwork for the dam 80 percent complete, cleaning the dam basin 50 percent complete, and the outlet works 100 percent complete. The project had been shut down for the winter months, and the Engineer would notify the state before resuming operations in the spring of 1969.

On May 12, 1969, a state representative visited the dam and met with the Owner. Water was found to be impounded to the normal pool level without the state being notified that the dam was finished and water was being ponded. Several deficiencies were noted: earthwork not completed, riprap not placed on the upstream face, the crest was uneven, and there was seepage noted in the left abutment area. Considerable leakage of the spillway was noted in the joints between the wall and the floor. On May 19, the state ordered the Owner to open the outlet conduit gate and drain the impounded water at once.

On September 30, a state representative inspected the dam and found that the upstream slope had been reshaped in a satisfactory manner with a 2.5H:1V slope. On October 14, 1969, a state inspection noted that the Owner had closed the valve, contrary to instructions, and that the riprap did not cover the slope as indicated on the approved plans. On October 17, the Engineer submitted a plan to seal off the seepage in the spillway by the use of a cement grout, which was approved by the state. On November 12, state representatives inspected the site while cement grouting was in progress. The Owner was on the site and he was told to maintain the lower water level as directed by the September 24 letter; the outlet conduit gate was still closed.

In December, the Owner advised the state that, as a result of financial difficulties, he was unable to complete the project at that time. He also reported that the cement grout program did not completely seal off the leakage. He requested permission to impound water to the full height and stated that he planned to complete the riprap in the fall of 1970. In January 1970, the state gave permission for the reservoir to be filled to normal elevation. The state also approved a proposal by the Engineer for chemical grouting to be done in the spillway area to seal off the leakage. The state required that the grouting and completion of riprap downstream of the spillway channel be done before June 1, 1970. Chemical grouting of the spillway area was apparently done by the Royal Construction Company of Norristown, Pennsylvania, probably in the summer of 1970.

An October 1972 inspection of the completed dam indicated that it was generally in fair condition, and no action was recommended by the state. By June 1977, the general condition was still considered fair; however, the spillway condition had deteriorated to poor, with open joints, and the recommendation was made that the Owner should employ an engineer to evaluate the structure and to make necessary repairs. The April 1978 state inspection determined that the general appearance of the dam had deteriorated to poor and that no repairs had been made. The spillway walls were cracked and braced, seepage was occurring around the outlet, and the downstream toe was swampy. In June 1978, the Owner was ordered to retain the services of a registered professional engineer, experienced in the design and construction of dams, to make a detailed investigation of the safety of the dam and, within 45 days, submit to the department for its review and approval the professional engineer's report on the condition of the dam. The Owner was also ordered to immediately drain the lake at a safe rate to a point where no water was impounded, and to keep the outlet conduit gate in a fully open position after the lake had been drained. The order was signed by an Assistant Attorney General of Pennsylvania.

In October and November 1978, the Owner's engineer submitted plans for repairs to the dam. The state concurred with the recommendations of the Engineer, and reiterated the requirement to provide a complete engineer's report on the safety of the dam, including a stability analysis of the embankment and a hydraulic evaluation of the spillway. In December 1978, state representatives inspected the repair work to the spillway, and noted excavation for the new spillway wall exposed a line of gravel and wood running through the impervious clay core of the embankment about one foot above the spillway slab.

On March 1, 1979, Harvey D. George, Inc., building contractor/designer of Virginville, Pennsylvania, retained by the Owner to complete the repair work, wrote a letter to the state reporting what work had been done at the dam during the winter. On March 16, 1979, F. T. Kitlinski & Associates, Inc., of Harrisburg, Pennsylvania, wrote to the state, informing them that they had been engaged by the Owner to perform a stability analysis as directed. They requested permission to review the files on the dam. On April 18, 1979, they submitted a report to the Owner. The report included a description of an inspection of the dam and made several recommendations, including the installation of piezometers and the drilling of two test borings at least ten feet into the original ground. The piezometers would provide information concerning the location of the phreatic line within the embankment, which would be useful for a stability analysis. Also recommended was increasing the reservoir level in stages. The state concurred with the report.

On June 28, 1979, Kitlinski & Associates, on behalf of the Owner, submitted the first report on the piezometer installation and test boring results to the state. The state then gave permission for the reservoir to be raised to elevation 349.5, and to be held there for 30 days before beginning the second stage increase. On August 20, 1979, the state gave permission to raise the reservoir to the normal pool elevation. Kitlinski has submitted monthly piezometer reading reports to the state. An analysis of the piezometer readings is beyond the scope of this investigation, and it is presumed that this data will be utilized by Kitlinski & Associates in performing the stability analysis required by the state.

h. Normal Operating Procedures. Under normal conditions, the pond drain gate is closed and water flows over the spillway weir at elevation 357.

1.3 Pertinent Data.

The summary of pertinent data for Christman Dam is presented as follows.

a.	Drainage Area (square miles)	2.3
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood at Dam Site	Unknown
	At Top of Dam	
	Design Conditions	3,400
	Existing Conditions	2,084

c.	Elevation (feet above MSL)	
	Top of Dam	
	Design	362.0
	Existing	360.8
	Principal Spillway Weir[1]	357.0
	Pond Drain Intake Invert (design)	335.5
	Conduit Outlet Invert	
	(design)	335.0
	(constructed)	333.7
	Downstream Toe	333.5±
d.	Reservoir Length (feet)	
	Length at Normal Pool	3,700
e.	Storage (acre-feet)	
	Normal Pool	234
	To Top of Dam	
	Design	350
	Existing	322
f.	Reservoir Surface Area (acres)	
	Normal Pool	20.5
g.	Embankment Data	
	Type	Zoned earth
	Volume	26,000 cu yds
	Length	630 feet
	Height (existing)	27 feet
	Top Width	20 feet
	Side Slopes	
	Upstream	
	Designed	2.5H:1V
	Constructed	2.5H:1V
	Downstream	
	Designed	2.5H:1V
	Constructed	2H:1V
	Cutoff	Trench constructed under dam centerline
	Grout Curtain	None
h.	Spillway	
	Type	Side entrance concrete channel

(1) All elevations are relative to an assumed spillway crest elevation of 357.0.

	Elevations	
	Weir Crest	357.0'
	Trough Under Dam Centerline	341.5
i.	Pond Drain	
	Type	24" reinforced concrete conduit under dam gated at downstream end
	Intake Invert Elevation	335.5
	Outlet Invert Elevation	333.7

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. The data available for review are contained in the Pennsylvania Department of Environmental Resources (DER) files. These data include the hydrology and hydraulic design, structural design of the spillway and retaining walls, an embankment stability analysis, and the design drawings.

b. Design Features. The principal design features of Christman Dam are illustrated on the plans and cross-sections enclosed in Appendix E as Plates 2 through 7. Data for these sections were obtained from the drawings located in DER files. A description of the design features is also described in Section 1.2, paragraph a, and pertinent data relative to the structure is presented in Section 1.3.

2.2 Construction.

The known construction history is presented in Section 1.2, paragraph g. The construction data are contained in the state inspection reports, copies of correspondence and photographs located in DER files.

2.3 Operational Data.

There are no operational records maintained. There are no minimum flow requirements downstream of this dam.

2.4 Evaluation.

a. Availability. Information presented herein was obtained from records located in DER files in Harrisburg, Pennsylvania, and from conversations with the Owner.

b. Adequacy. The available data included in the state files and presented in this report are not adequate to evaluate the engineering aspects of the dam and appurtenant structures.

c. Validity. The validity of the original hydrology design is suspect in that unique characteristics of the watershed have been neglected; see Section 5. Also, the validity of the embankment stability analysis is questioned because of the use of inappropriate soil parameters; see Section 6.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. Observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix A, and are summarized and evaluated as follows. In general, the appearance of the facility in November 1979, indicates that the dam is in poor condition. Plans and cross-sections of the dam are shown on Plates 2 and 7, Appendix E.

b. Dam. During the visual inspection, there were no indications of distortion in alignment or grade that would be indicative of movement of the embankment or foundation. The vertical alignment of the dam was checked and spot elevations are shown on Plate 2, Appendix E. No discernible horizontal displacement or bulging was noted along the crest. Over 350 feet of the dam crest was observed to be below design elevation, with a maximum difference of 1.2 feet noted. Increasing the crest to design elevation will increase the dam height to 28.5 feet. Some portions of the crest appear to have recently been filled in, indicating that the crest had been even lower prior to the field inspection. The recent fill contained deleterious material, such as wood.

Although the upstream slope at the waterline is at least partially protected by riprap, a bench was noted just below the water surface. Additional stone has been placed on the upstream slope adjacent to the spillway, as shown in Photograph 15, Appendix C, which reduces the spillway capacity. Fairly large trees are currently rooted in the riprap zone; see Photograph 5. Other large trees grow on the downstream slope; see Photographs 7 and 8. It is noted that some trees have been removed, except that the root mass has been left in the embankment. The downstream slope is protected with Crownvetch, but also supports several large trees and other woody vegetation. The downstream slope near the maximum section was damaged, possibly by a truck or track mounted vehicle, when piezometers were installed; see Photograph 9. This damage should be repaired.

The upstream slope could not be inspected below the water level, elevation 357. It is reported by F. T. Kitlinski & Associates that quarried limestone riprap is present from elevation 359± to 354±. Below that level, the slope is covered with small pieces of shale which has little useful function. It is also reported that a 12 to 15 inch high bench has been etched into the upstream slope at elevation 342± by wave action.

Some erosion is taking place on the embankment behind the spillway wall; see Photograph 14. Additional "derrick" stone has been placed at the discharge end of the spillway chute and additional fill materials placed at the toe of the downstream slope adjacent to the downstream channel. The fill materials contain wood and plastic material, and appear to be uncompacted.

Between the spillway chute and the discharge conduit outlet, slightly downstream of the toe, a marshy area was noted, as shown on sheet 5a, Appendix A. Seepage was also noted exiting the embankment from the left side of the outlet conduit, as shown in Photograph 13. This seepage could either be embankment seepage intercepted by the rock toe or seepage along the conduit.

To the left of the outlet conduit is a 1.5 inch I.D. hose. Photograph 11 shows the intake on the upstream side; Photograph 12 shows the exiting end of the hose. The hose passes through the embankment at an undetermined depth below the crest. The original purpose of the hose was to supply water to the fish ponds at the downstream toe. Reportedly, the intake to the hose is blocked with a piece of wood. There are three fish ponds on the downstream edge of the embankment. The one at the lowest elevation can be seen in the overview photograph and Photograph 7. Seepage was noted to be flowing from the base of the fish pond embankment, and the pond could be masking seepage through the embankment.

c. Appurtenant Structures.

1. Spillway. The overall condition of the side entrance spillway is considered fair. The sediment accumulation and/or fill upstream of the weir decreases the hydraulic efficiency. The recently placed rock shown in Photograph 15 reduces the effective length of the weir by an estimated ten percent. Considerable seepage was noted through the right trough wall and through the weir. Some settlement of backfill behind the right trough wall was noted. The left-hand retaining wall of the transition section and chute downstream of the dam centerline had been displaced inward and was recently replaced. Photograph 17 shows the junction of the old and the new concrete. Photograph 18 shows what appears to be fiberglass insulation embedded in the concrete. Its purpose is unknown. The chute walls under the bridge at the dam centerline are out of plumb, leaning inward by as much as four inches at the top.

The spillway chute downstream of the dam centerline appears to be in good condition. Recently, a broken portion of the floor was replaced, and additional rock was placed at the discharge end and concreted over in an effort to hold it in place.

2. Outlet Works. Photograph 3 shows the discharge end of the 24 inch pond drain conduit. Discharge through the conduit is controlled at the downstream end by a cast iron sluice gate. The gate was leaking slightly before it was exercised, and leaked more after it was exercised. Reportedly, it can be sealed off completely. Boards have been placed around the gate to protect the operator from spray when the gate is opened. Discharge from the conduit joins the main spillway channel about 100 feet below the dam toe.

d. Reservoir. The reservoir slopes are moderate to steep and vegetated to the water's edge with grass or trees. Some sediment has accumulated at the upper end. The Owner reported that he had removed sediment at one time. Homes are built along the reservoir's perimeter.

e. Downstream Channel. For about 1,000 feet below the dam, the channel flows through a fairly wide floodplain, as shown in Photograph 4. At about 1,000 feet below the dam, water passes under PA Route 143 through two four foot diameter corrugated metal culverts. Debris has accumulated at the upstream end so that water is ponded above the top of the culverts. The channel between the dam and the culverts is about 11 feet wide and 0.5 to 1.5 feet deep. The floodplain is open to brush covered. About 2,000 feet below the dam, the stream enters Maiden Creek. About 1.25 miles farther downstream is Virginville, where several homes are built in the floodplain. At Virginville, Pennsylvania, Route 143 crosses Maiden Creek. Although the Maiden Creek floodplain is fairly wide just below Christman Dam, it narrows considerably at Virginville. The Route 143 highway bridge also forms a constriction at Virginville, so that when water is flowing over the bridge, the first stories of the houses immediately upstream will be flooded. Failure of Christman Dam would result in excessive property damage and possible loss of life at this location, thus justifying a "High" hazard classification.

3.2 Evaluation.

In summary, the visual survey of the dam and appurtenant facilities disclosed several areas of immediate concern. The embankment itself is considered to be in poor condition, with most of the crest being below design grade. Large trees exist on the embankment, and some have been pulled over leaving the root masses in the embankment. Seepage is also observed adjacent to the pond drain conduit. As the spillway trough wall was designed with rock anchors and founded against bedrock, seepage through that wall is not considered to be detrimental; although, it is to be noted that backfill behind the wall has subsided.

The spillway is assessed to be in fair condition. However, sediment or fill and recently placed rock upstream of the weir have reduced the effective weir length and should be removed. The left spillway retaining wall has recently been repaired, but the quality of the repair cannot be assessed.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Operation of the dam does not require a dam tender. Under normal conditions, all water is discharged through the side channel spillway at the right end of the embankment.

4.2 Maintenance of the Dam.

The dam is maintained by the Owner. As noted in Section 1.2, paragraph g, major repairs are undertaken only at the direction of the state.

4.3 Maintenance of Operating Facilities.

The sluice gate is operated twice a year in the spring and fall. The reservoir level is lowered to clean the upper end of sediment and debris.

4.4 Warning Systems In Effect.

There are no written warning systems or procedures established to be followed during periods of exceedingly heavy rainfall. The Owner indicated that in the event of an emergency, he would notify the local fire department.

4.5 Evaluation.

It is judged that the current operating procedure, which does not require a dam tender, is a realistic means of operating the relatively simple control facilities of Christman Dam. However, some of the current maintenance procedures are considered to be potentially detrimental, particularly the method of removing large trees, and the inclusion of deleterious material, such as wood, in embankment fill. The Owner's engineer should prepare an operation and maintenance manual.

In conclusion, it is noted that formal operational, maintenance and warning procedures should be developed and implemented as soon as possible. These procedures should include an inspection checklist, consisting of a list of items to be checked during each inspection and repaired as necessary to insure proper performance of the structure.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. The original hydrologic and hydraulic design is in the Department of Environmental Resources files and was available for review. The watershed is about 2.2 miles long and averages about 1.2 miles wide, having a total drainage area of 2.3 square miles. Elevations within the watershed range from about 665 feet in the upper reaches to 357 at normal pool elevation. The watershed is predominantly open/farmland with scattered residential development. Development can be expected to continue at a slow rate within the watershed.

In accordance with criteria established by Federal (OCE) Guidelines, the spillway design flood for this "Small" size dam and "High" hazard classification is 0.5 to 1.0 PMF (Probable Maximum Flood). As the height of this dam is near the lower limit for small size dams, and the existing total capacity is about one-third of the upper limit, the selected spillway design flood is 0.5 PMF.

b. Experience Data. There are no records of reservoir levels or rainfalls kept for this dam. It was reported that Hurricane Agnes, June 1972, increased the reservoir level by about five inches. It is to be noted that the dam does not lie in the path of the maximum rainfall for that event.

c. Visual Observations. On the date of the inspection, conditions were observed that would indicate a reduced spillway capacity during an extreme event. Fill was placed upstream of the weir, reducing its hydraulic efficiency; recently, rock was placed on the upstream slope of the embankment, reducing the effective length of the weir; and because of the low crest elevation, the full spillway capacity cannot be utilized before the embankment overtops. Other observations regarding the condition of the downstream channel, spillway and reservoir are located in Appendix A and discussed in greater detail in Section 3. Recommendations are made in Section 7.

d. Overtopping Potential. Although the original hydrologic study was included in the state's files, it was not used in the evaluation of the overtopping potential of this dam because the original spillway design flood was less than one-half the PMF and the original study failed to take into account a unique characteristic of this watershed. As shown on Plate 1, Appendix E, the path of the maximum water course

curves back on itself, thus making the length of the maximum water course, which is 3.5 miles, much greater than the length of the watershed, 2.2 miles.

The overtopping potential of this dam was estimated using the HEC-1 Dam Safety Version computer program. A brief description of the program is included in Appendix D. The computer program estimated the peak inflow from one-half the PMF to be 1,852 cfs. The flood routing was done assuming both design conditions and existing conditions. The spillway is estimated to pass about 2,094 cfs under existing conditions and 3,104 cfs under design conditions without overtopping the embankment. Under design conditions, the spillway can pass about 0.88 PMF without overtopping the embankment. Under existing conditions, the percentage of the PMF passed is reduced to 0.59 PMF.

e. Spillway Adequacy. As the spillway can pass the selected spillway design storm, 0.5 PMF, under existing conditions, the spillway is considered "Adequate".

f. Downstream Conditions. For about 2,000 feet below the dam, the channel flows through a fairly wide floodplain before joining with Maiden Creek. Maiden Creek is wide just below Christman Dam and narrows considerably at Virginville, 1.25 miles farther downstream, the site of the downstream damage center. The Route 143 highway bridge forms a constriction at Virginville, so that when water is flowing over the bridge, the first floor of the houses immediately upstream will be flooded. Failure of Christman Dam would result in excessive property damage and loss of life, thus justifying a "High" hazard classification.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual observations detected no evidence of existing or pending embankment or spillway instability. The upstream and downstream slopes appear to be stable, but trees are growing on the embankment which should be removed properly. Also, vertical cuts have been made on the downstream slope for access roads during piezometer installation, and these should be repaired. The spillway walls under the bridge at the dam centerline are leaning inwards, but were probably constructed in that manner. The backfill behind the right spillway wall has subsided, possibly due to soil being removed by seepage through the base of the wall or to poor backfill compaction.

b. Design and Construction Data. A stability analysis of the maximum embankment section was performed as part of the design in July 1967, by General Consultants, Inc., using a simplified wedge analysis. However, the analysis is inadequate for the following reasons:

1. An inappropriate soil strength was used. A relatively high friction angle of 43 degrees was used, based upon two direct shear tests on undisturbed samples from a boring at an unknown location. Shear tests should have been conducted on remolded samples, compacted to the minimum density specified for construction.

2. The stability analysis considered the downstream slope to be 2.5H:1V, but the actual constructed slope is about 2H:1V.

Compaction tests (ASSHO T-99, "Standard Proctor") were conducted by Allentown Testing Laboratory, Inc., on "pervious" and "impervious" borrow soils for use in construction of the dam shell and core, respectively. However, from the appearance of the resulting compaction curves, it appears likely that the results were interchanged; that is, the curve which appears to be appropriate for pervious soil was reported as resulting from the impervious soil, and vice versa.

The only in-place density test results in the state file indicated relative compactions of 93.8 and 97.8 percent of AASHO T-99 for the "pervious" and "impervious" fill materials, respectively, in "the best placed soil fill". The Owner was advised to increase the compaction effort and the soil moisture content in order to meet the 100 percent relative compaction specified. If the compaction standards

were reversed, as described above, the in-place relative compaction for these materials would be 89.3 and 103.7 percent for the "pervious" and "impervious" fill, respectively. The actual conditions are further confused since the inspection report indicates that the "pervious" soil fill was placed in the core area of the dam and the "impervious" soil fill in the shell area. The degree of compaction of subsequently placed fill is unknown.

Because of the deficiencies in design and construction noted above, and consistent with the history of poor construction practices connected with this dam, as described in detail in Section 1.2, paragraph g, it is concluded that the stability of this dam cannot be considered to be adequate without a detailed study including test borings, laboratory testing and engineering analysis.

c. Operating Records. There are no operating records for this structure.

d. Post-Construction Changes. As described in Section 1.2, paragraph g, and Section 3, the following post-construction changes have been made to the dam:

(1) In November 1969, cement grout was injected around the spillway to stop seepage. The seepage was not completely stopped.

(2) In 1970, chemical grout was injected around the spillway to stop seepage. Again, the seepage was not completely stopped.

(3) In 1978, a portion of the spillway chute wall, which had rotated inwards, was replaced.

(4) In 1978, derrick stone was placed and grouted at the outlet of the spillway chute, and a broken portion of the chute floor was replaced.

(5) The spillway capacity has been reduced by the placement of stone riprap on the embankment adjacent to the spillway.

(6) A fish pond has been constructed at the left toe of the dam which may be masking seepage. A 1.5 inch diameter hose passes through the embankment at an unknown depth to provide water to the pond.

(7) Four piezometers were installed in June 1979.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it is considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. However, as the stability of the dam cannot be assessed under static loading conditions, it cannot be assessed under seismic loading conditions.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection and review of design documentation indicate that the spillway is in fair condition. However, because of the low crest elevation, seepage, and excessive woody vegetation, the overall evaluation of Christman Dam is considered poor.

Hydrologic and hydraulic computations presented in Appendix D indicate the structure will pass the selected spillway design flood, one-half the Probable Maximum Flood, without overtopping. Therefore, the spillway systems of this structure are considered to be "Adequate". In the event the dam fails while retaining a significant quantity of water, extreme property damage and possible loss of life in the downstream town of Virginville would be expected, thus justifying the "High" hazard classification.

b. Adequacy of Information. Information available for this investigation was not sufficiently adequate to evaluate the structural aspects of the dam.

c. Urgency. It is recommended that the remedial measures presented in Section 7.2 be implemented immediately.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following steps be taken immediately, and should be done under the supervision of a registered professional engineer experienced in the design and construction of dams.

(1) The embankment stability analysis requested by the state should be performed, using constructed slope angles and as-built soil parameters obtained from undisturbed samples.

(2) The crest elevation should be increased to meet the design elevation.

(3) The trees and root masses should be completely removed and the slope restored to its original condition. All woody vegetation should be cut on an annual basis.

(4) Additional backfill should be placed behind the spillway chute walls.

(5) The riprap partially blocking the weir should be removed.

(6) The hose through the embankment should be removed and the embankment returned to its original condition.

(7) Provide a method of upstream closure of the pond drain conduit.

b. Operation and Maintenance Procedures. Because of the location of the dam and the potential for heavy property damage and possible loss of life in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents if high flows are expected and provisions for evacuating these people in the event of an emergency. In addition, the Owner's engineer should develop a detailed maintenance and operation procedure to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

APPENDIX

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Christman Dam* County *Berks* State *Pennsylvania* National ID # *PA 00721*

Type of Dam *Earth* Hazard Category _____

Date(s) Inspection *11/21/79* Weather *Sunny* Temperature *60's*

Pool Elevation at Time of Inspection *357* M.S.L. Tailwater at Time of Inspection *N/A* M.S.L.

Inspection Personnel:

Mary F. Beck (Hydrologist) *Vincent McKeever (Hydrologist)*

Arthur H. Dvinoff (Geotechnical) *John H. Frederick, Jr. (Geotechnical)* *(1/80)*

Raymond S. Lambert (Geologist)

Mary F. Beck Recorder

Remarks:

Mr. Carl Christman, Owner, was on site and provided assistance to the inspection team.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*N/A*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*N/A*	
DRAINS	*N/A*	
WATER PASSAGES	*N/A*	
FOUNDATION	*N/A*	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*Erosion has occurred near the downstream toe to the left of the outlet conduit in the vicinity of seepage, see Sheet 5a. An access road has been cut on the downstream slope for installation of piezometers. The cut area should be repaired.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*Horizontal alignment was good. The vertical alignment was checked and for a distance of over 350 feet the dam crest was found to be below the design elevation with a maximum of 1.2 feet below design elevation.*	
RIPRAP FAILURES	*According to DER files, upstream riprap below elevation 354± is shale and has little useful function.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	*The Crownvetch cover is thin in places. The Owner permits trees to grow on the embankment up to 5 inches in diameter before pulling them out by the roots. Woody vegetation should be cut annually and not permitted to grow an extensive root system.*	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*The left junction of embankment and abutments appears in good condition. Settlement of recent backfill to spillway chute walls permits water to pond and has created a potential for surface runoff to cause erosion. More backfill should be placed and graded to drain.*	
ANY NOTICEABLE SEEPAGE	*See Sheet 5a. Seepage was noted from under a fish pond located immediately downstream of the dam. It could not be determined if the seepage was from the fish pond or from the main reservoir.*	
STAFF GAGE AND RECORDER	*None*	
DRAINS	*None*	

(1) Fill upstream of weir reduces hydraulic efficiency. (See Photograph No. 1)

(2) Rock placed upstream of weir reduces effective length of weir. (See Photograph No. 15).

(3) Retaining wall replaced spring, 1979. (See Photograph No. 17).

(4) Settlement of backfill behind spillway wall.

(5) Minor erosion behind spillway wall. (See Photograph No. 14).

(6) Recently placed grouted derrick stone.

(7) Large trees on embankment, some have been pulled out by their roots. (See Photographs No. 5 and 10).

(8) Seepage beside outlet conduit. (See Photograph No. 14).

(9) Marshy area.

(10) Lowest fish pond, may mask seepage. (See Overview Photograph).

(11) Hose for water spray to fish pond. (See Photograph No. 11 and 12).

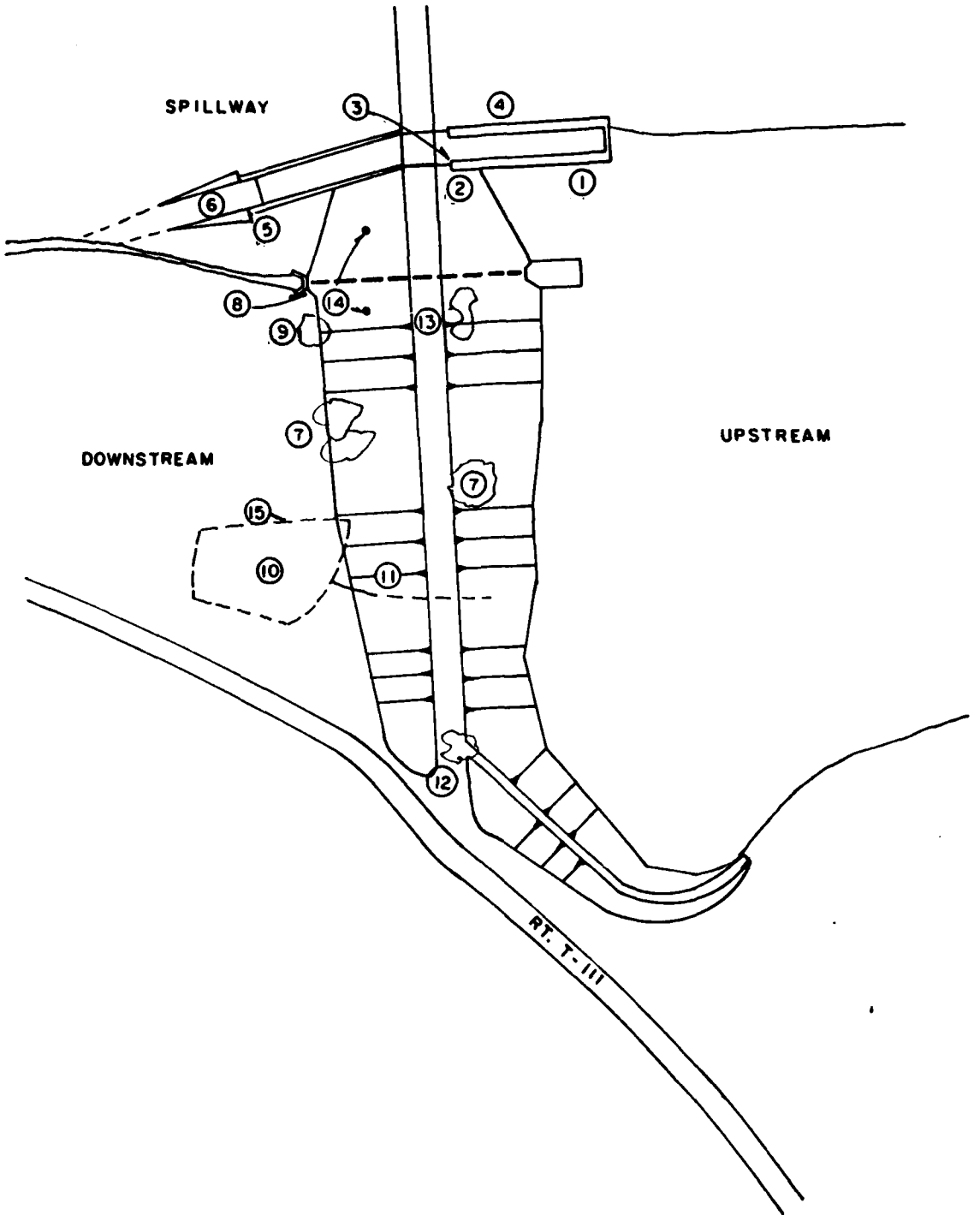
(12) Access road not built as shown. (See Overview Photograph).

(13) Crest is lower than design elevation for more than 350 feet.

(14) Piezometers installed, embankment damaged and should be repaired. (See Photographs No. 8 and 9).

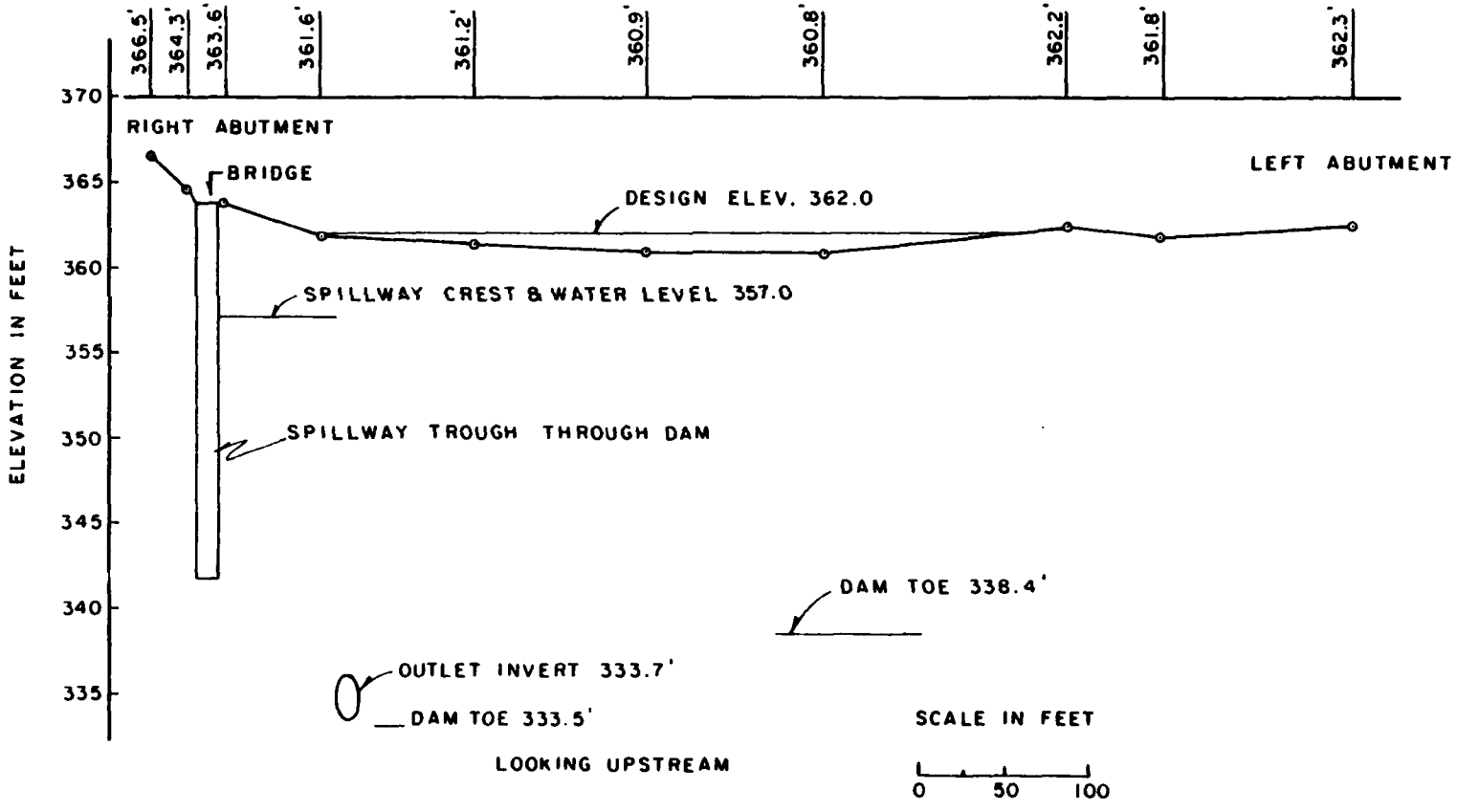
(15) Seepage emerging from base of fish pond embankment.

FIELD OBSERVATION PLAN
CHRISTMAN DAM



FIELD OBSERVATION PLAN
CHRISTMAN DAM

SHEET 5B OF 11



FIELD OBSERVATION PROFILE
CHRISTMAN DAM

SHEET 5C OF 11

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*The crest of the weir appears to be fairly level, although water nas not flowing over the full length of the weir. Soil has been placed upstream of the weir partially preventing flow over weir. Soil would be washed away during a large storm. However, riprap placement has reduced the effective length of the weir.*	
APPROACH CHANNEL	*None*	
DISCHARGE CHUTE	*The concrete discharge chute appears in fair condition with several leaks. Leaks range in volume from damp spots to flow from an opening about 1/2-inch diameter.*	
BRIDGE AND PIERS	*The bridge over the spillway chute appears in satisfactory condition, there are no piers. The spillway walls under the bridge are not plumb.*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*Four piezometers have been installed at two locations as shown on Sheet 5a.*	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*The reservoir side slopes are moderate to steep with homes and trailers around the shore.*	
SEDIMENTATION	*Some sediment at upper end, little or no effect on floodwater storage.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*About 1,000 feet downstram of the dam, water passes under PA Route 143 through two-4 foot CMP. Debris has accumulated in/at the upstream end so that water has ponded on the top of the CMP. The channel between the dam and culverts is about 11 feet wide and 0.5 to 1.5 feet deep. The floodplain is open to brush covered.*	
SLOPES	*The valley gradient is about 0.005.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*About 2,000 feet below the dam, the stream enters Maidén Creek. About 1.25 miles futher downstream is Virginville where several homes are built in the floodplain.*	

APPENDIX

B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Christman Dam*

ID # *PA 00721*

ITEM	REMARKS
AS-BUILT DRAWINGS	*None available.*
REGIONAL VICINITY MAP	*Plate 1, Appendix E.*
CONSTRUCTION HISTORY	*See Section 1.2, paragraph 'g'*
TYPICAL SECTIONS OF DAM	*See Appendix E.*
OUTLETS - PLAN	*See Appendix E.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*See Appendix D.*
RAINFALL/RESERVOIR RECORDS	*None.*

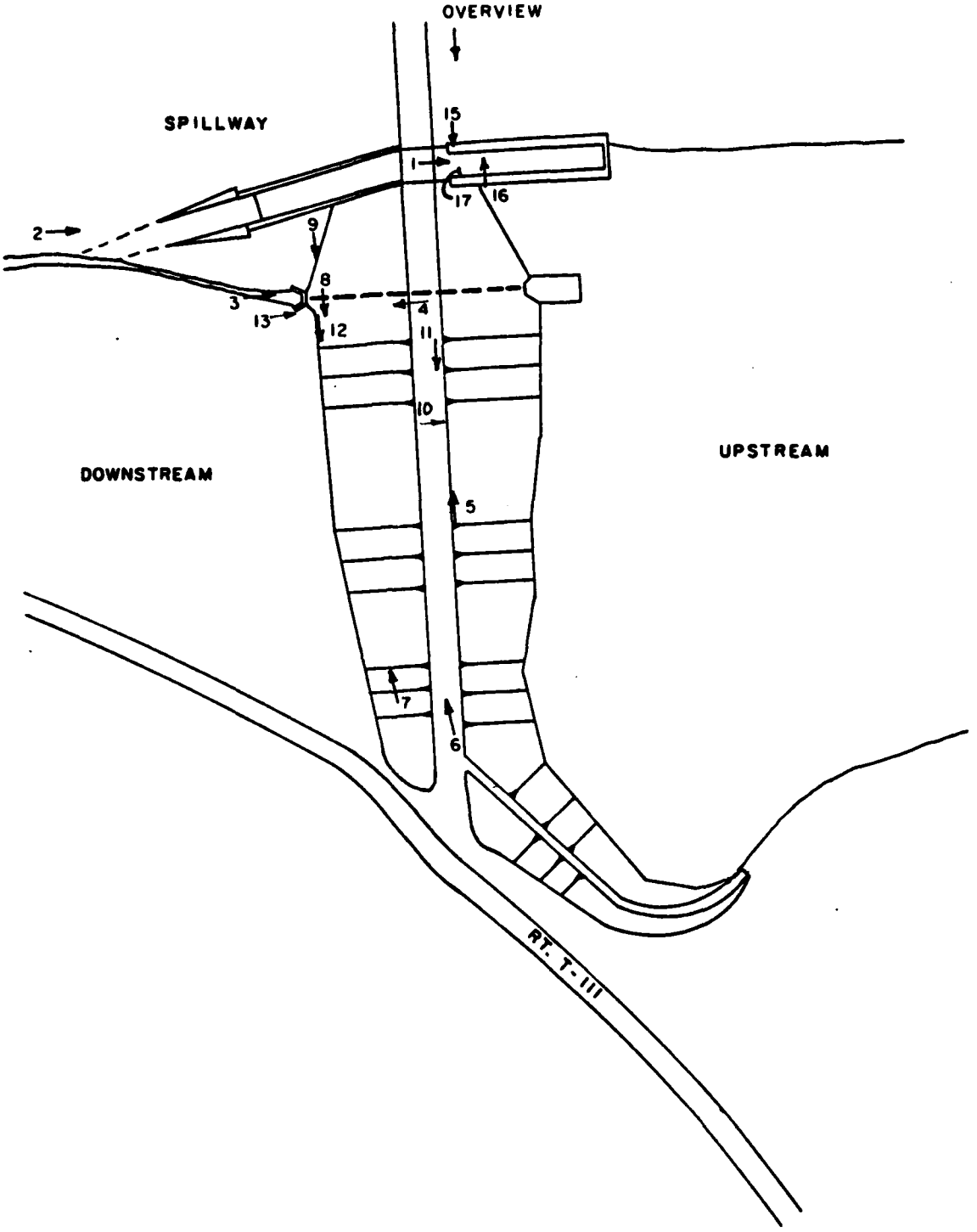
ITEM	REMARKS
DESIGN REPORTS	*Located in DER files.*
GEOLOGY REPORTS	*See Appendix F.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	*Reports are in DER files.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*Some records are in DER files.*
POST-CONSTRUCTION SURVEYS OF DAM	*See Plate 2, Appendix E.*
BORROW SOURCES	*Reservoir area.*

ITEM	REMARKS
MONITORING SYSTEMS	*Four piezometers installed at two locations.*
MODIFICATIONS	*None*
HIGH POOL RECORDS	*None*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*The State has directed the Owner to have his engineer prepare a stability analysis.*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*Spillway retaining walls had been dislocated and were replaced in Spring 1979.*
MAINTENANCE OPERATION RECORDS	*None*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E.*
OPERATING EQUIPMENT PLANS & DETAILS	*Operating equipment is limited to the cast-iron sluice gate at the downstream end of the pond drain conduit.*
MISCELLANEOUS	1. *Correspondence, memos, and state inspection reports in DER files.* 2. *41 black and white and 42 color photographs taken during construction, inspection and repair of spillway.* 3. *Inspection reports prepared by Owner's Engineers.*

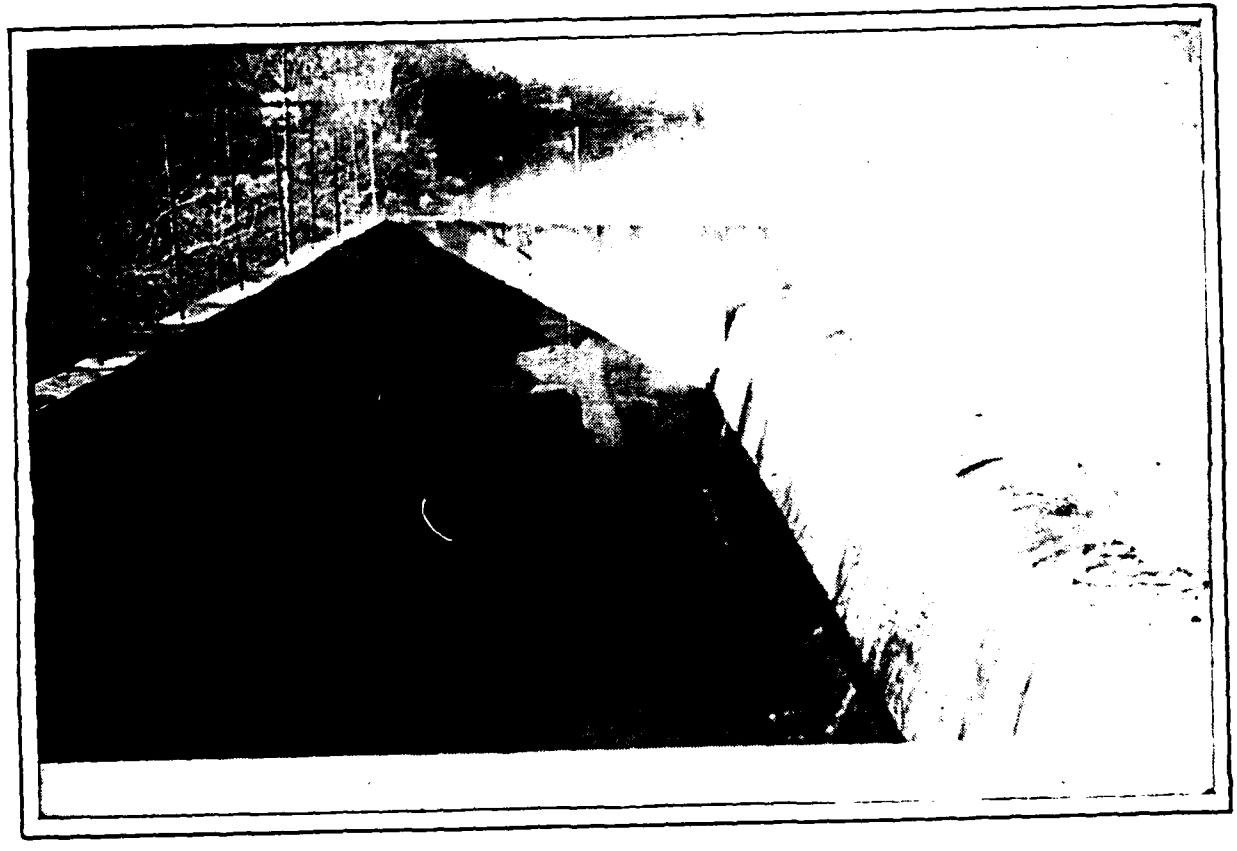
APPENDIX

C



PHOTOGRAPH LOCATION PLAN
CHRISTMANS DAM

PLATE C-1

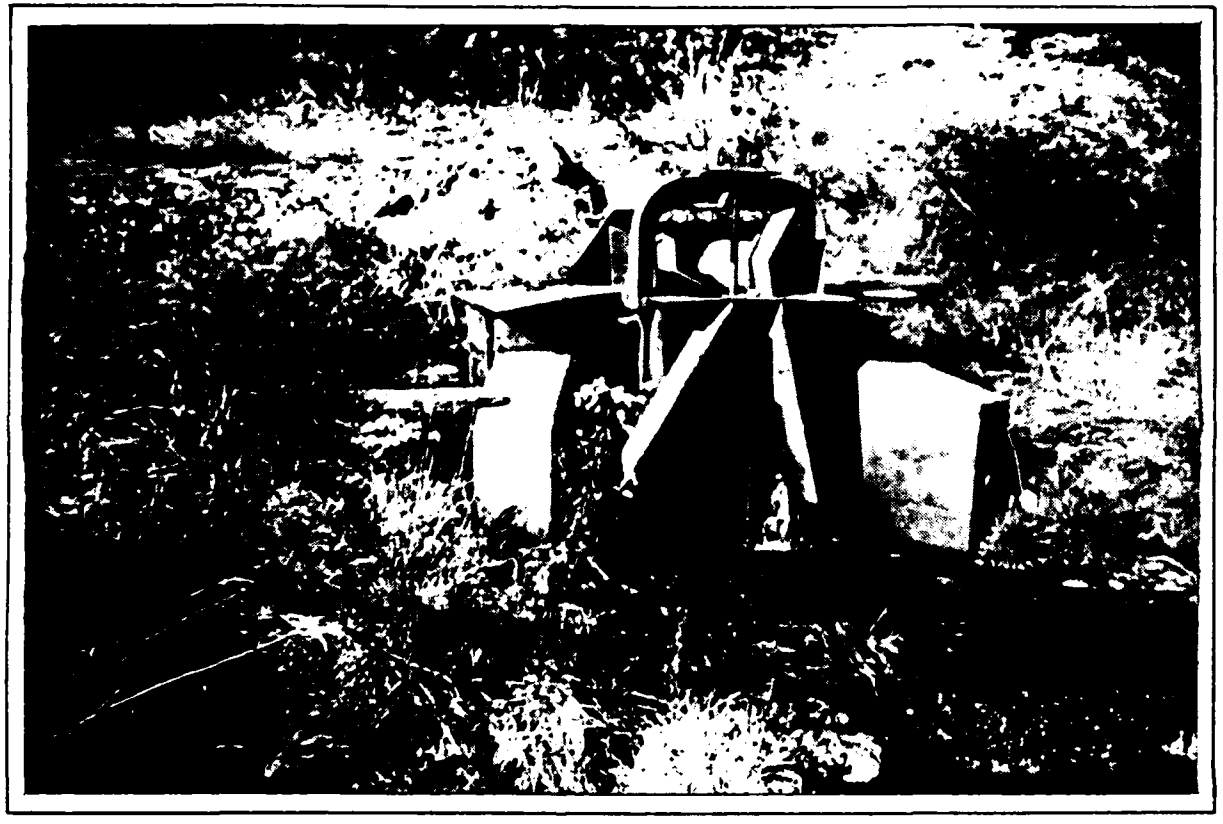


VIEW OF SPILLWAY FROM BRIDGE. NOTE WEEDS GROWING IN WATER IMMEDIATELY UPSTREAM OF WEIR.

PHOTOGRAPH NO. 1

VIEW OF SPILLWAY CHUTE AND DOWNSTREAM CHANNEL.

PHOTOGRAPH NO. 2



POND DRAIN OUTLET. BOARDS PLACED TO PROTECT OPERATOR FROM SPRAY WHEN GATE IS OPENED.

PHOTOGRAPH NO. 3

OVERALL VIEW OF DOWNSTREAM AREA.

PHOTOGRAPH NO. 4

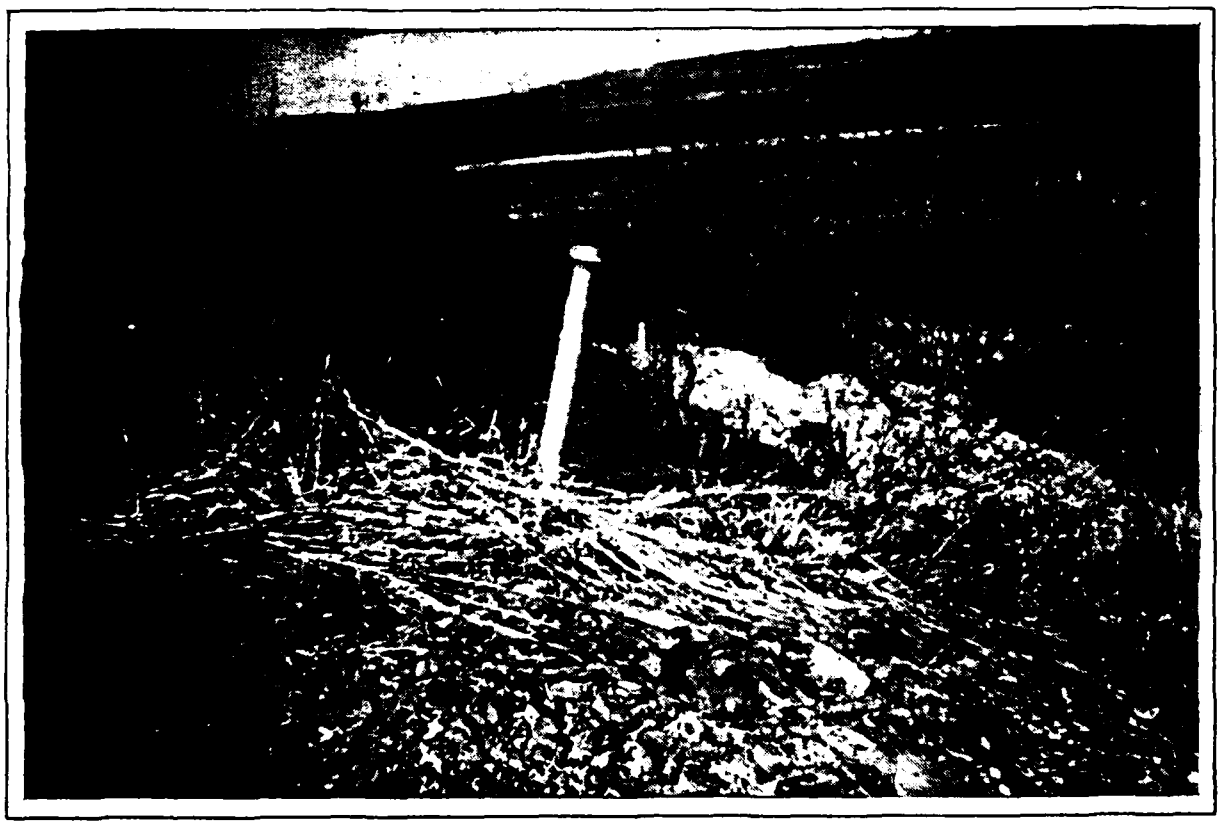
UPSTREAM SLOPE. PHOTOGRAPH NO. 5

ROADWAY OVER DAM. GRAVEL WAS RECENTLY ADDED TO A LOW SPOT.

PHOTOGRAPH NO. 6

OVERALL VIEW OF DOWNSTREAM SLOPE.
NOTE LARGE TREES IN CENTER OF
PICTURE AND FISH POND ON LEFT SIDE
OF PICTURE.

PHOTOGRAPH NO. 7



PIEZOMETER INSTALLED ON DOWNSTREAM SLOPE.

PHOTOGRAPH NO. 8

DAMAGE TO EMBANKMENT AS A
RESULT OF PIEZOMETER
INSTALLATION.

PHOTOGRAPH NO. 9

TREE PULLED OVER.

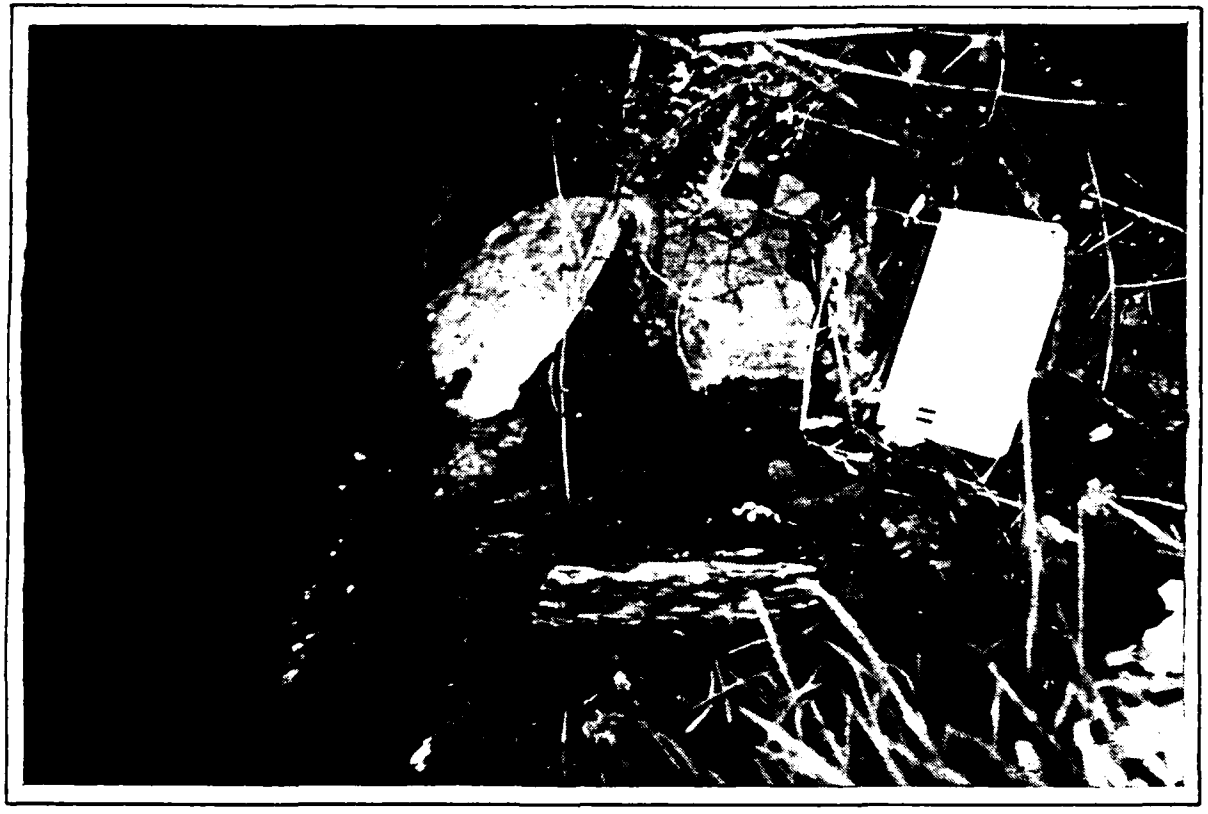
PHOTOGRAPH NO. 10

INTAKE FOR HOSE TO SPRAY WATER ON
DOWNSTREAM FISH POND.

PHOTOGRAPH NO. 11

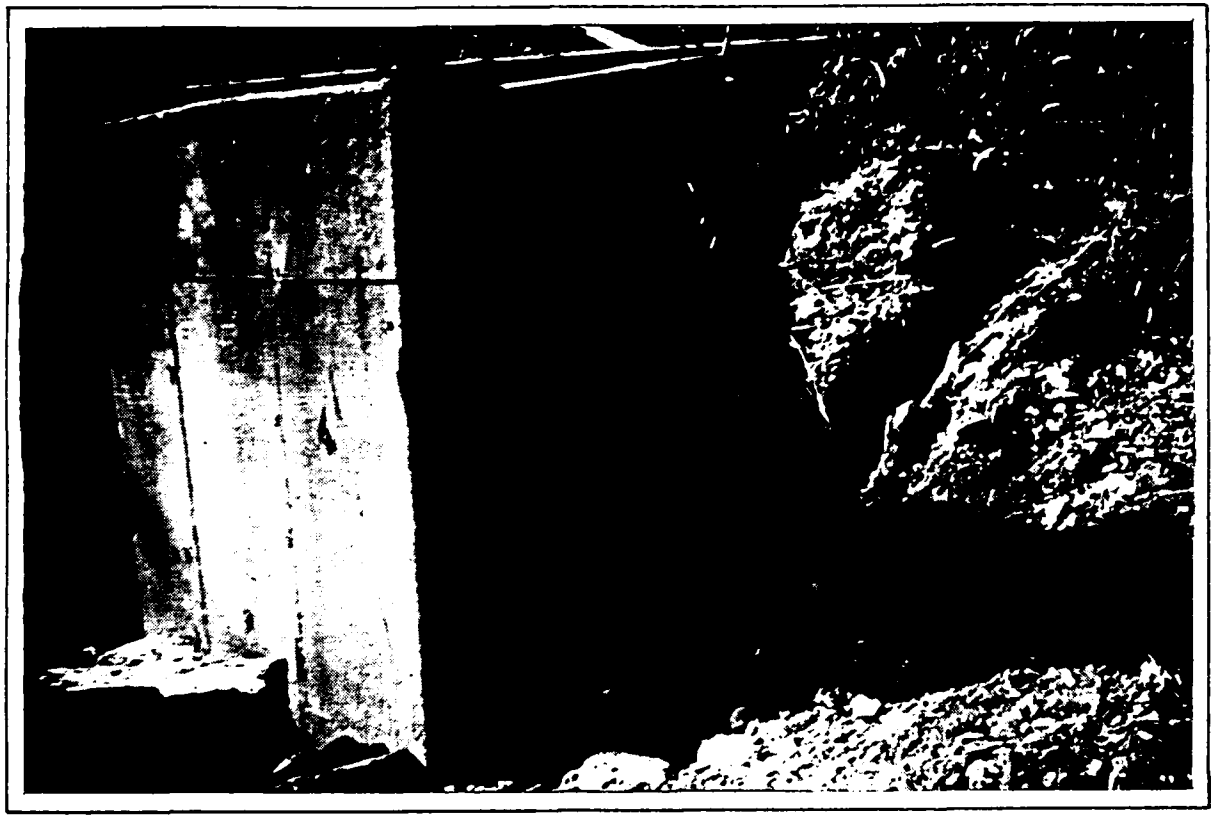
HOSE FORMERLY USED TO SPRAY
WATER ON FISH POND.

PHOTOGRAPH NO. 12



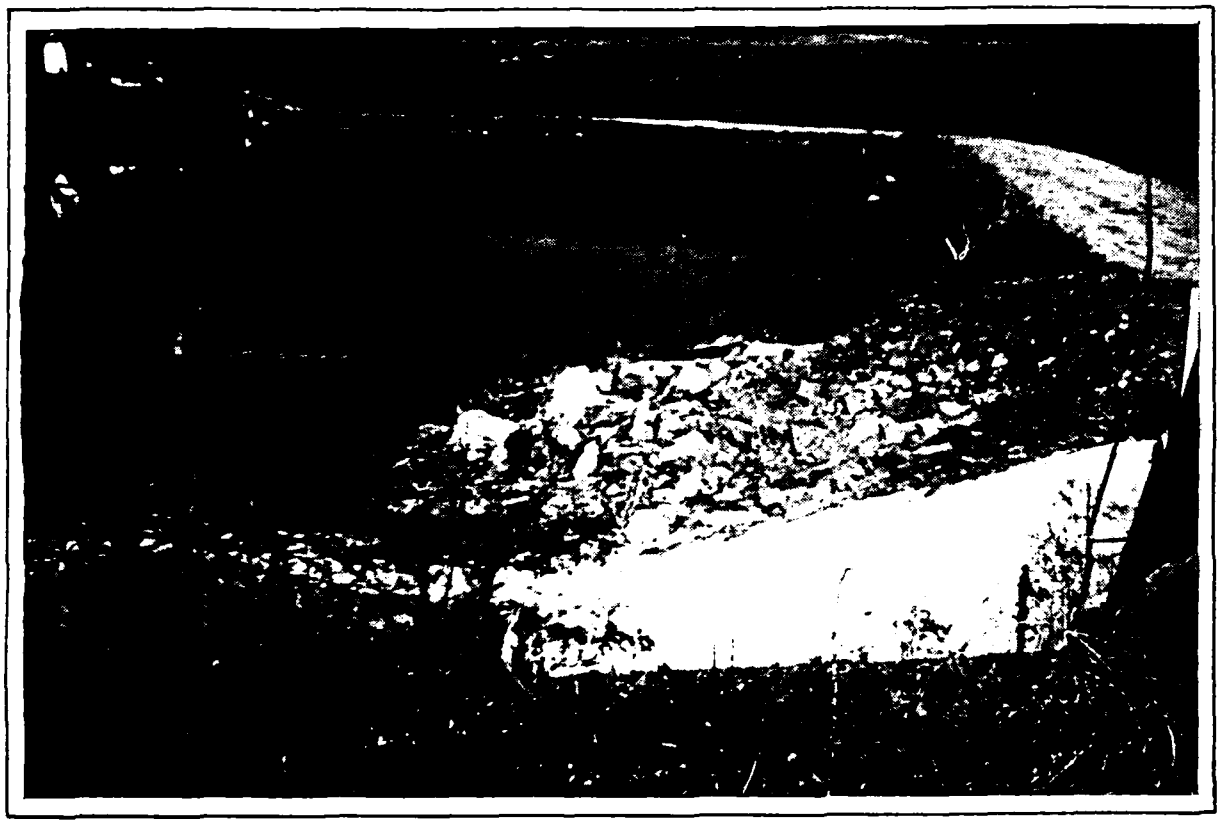
EMBANKMENT SEEPAGE FROM LEFT SIDE
OF OUTLET STRUCTURE.

PHOTOGRAPH NO. 13



EROSION AT LEFT SIDE OF SPILLWAY
OUTLET.

PHOTOGRAPH NO. 14



RECENTLY PLACED RIPRAP ON UPSTREAM SLOPE REDUCES THE EFFECTIVE LENGTH OF THE WEIR.

PHOTOGRAPH NO. 15

SEEPAGE THROUGHOUT SPILLWAY TROUGH
RIGHT WALL.

PHOTOGRAPH NO. 16

JUNCTION OF OLD AND NEW
CONCRETE.

PHOTOGRAPH NO. 17

WHAT APPEARS TO BE FIBERGLASS INSULATION HAS BEEN USED AS JOINT FILLER.

PHOTOGRAPH NO. 18

DOWNSTREAM DAMAGE CENTER ON MAIDEN
CREEK ABOUT ONE MILE BELOW THE DAM.

PHOTOGRAPH NO. 19

APPENDIX

D

CHRISTMAN DAM

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *Predominantly open/farmland, few homes.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *357.0 feet (234 Acre-Feet).*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *360.8 feet (322 Acre-Feet) existing.*

ELEVATION MAXIMUM DESIGN POOL:

ELEVATION TOP DAM: *362.0 feet, design; 360.8 feet, existing.*

SPILLWAY

a. Elevation *357.0 feet.*

b. Type *Side entrance channel with concrete weir.*

c. Width *100 feet (weir length).*

d. Length *187 feet.*

e. Location Spillover *Right abutment.*

f. Number and Type of Gates *None*

OUTLET WORKS:

a. Type *24 inch conduit at base of dam, gated at downstream end.*

b. Location *Station 2 + 00, maximum section.*

c. Entrance inverts *335.5 feet.*

d. Exit inverts *335.0 feet.*

e. Emergency draindown facilities

HYDROMETEOROLOGICAL GAGES:

a. Type *None*

b. Location *N/A*

c. Records *N/A*

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined*

DRAINAGE AREA:(1) *2.3 square miles*

PROBABLE MAXIMUM PRECIPITATION (PMP)
FOR 10 SQ. MILES IN 24 HOURS:(2) *23.0 inches.*

ADJUSTMENT FACTORS FOR DRAINAGE AREA (%):(3)

Zone *6*

6 Hours *113%*

12 Hours *123%*

24 Hours *132%*

48 Hours *143%*

SNYDER HYDROGRAPH PARAMETERS:(4)

Zone *6*

C_p, C_t *0.40, 1.35*

L(5) *3.50 miles.*

Lca (6) *2.79 miles*

$tp=C_t\ (L \cdot Lca)^{0.3}$ *2.67*

SPILLWAY CAPACITY AT MAXIMUM
WATER LEVEL(7) *2094 cfs existing, 3104 cfs design*

---

(1) Measured from USGS maps.
(2) Hydrometerological Report No. 33, Figure 1.
(3) Hydrometerological Report No. 33, Figure 2.
(4) Information received from Corps of Engineers, Baltimore District.
(5) Length of longest water course from outlet to basin divide, measured from USGS maps.
(6) Length of water course from outlet to point opposite the centroid of drainage area, (see Plate 1, Appendix E) measured from USGS maps.
(7) See Sheet *10, 12* of this Appendix.

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quandrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputed and flows are routed downstream to the damage center and a dam breach analysis is performed.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

Classification (Ref - Recommanded Guidelines for Safety Inspection of Dams)

1. The hazard classification is rated as "High" as there would be excessive economic loss and loss of life in the event of failure.

2. The size classification is "Small" based on its 27 foot height and 350 Ac-Ft design total capacity.

3. The selected spillway design flood, based on size and hazard classification, is 0.5PMF (Probable Maximum Flood).

Hydrology and Hydraulic Analysis

1. Original Data. The original data was reviewed and judged not appropriate. The design storm was less than 0.5PMF and as the longest watercourse is unusually long for this size watershed, the design t_c was understated.

2. Evaluation Data

Inflow hydrograph parameters are shown on sheet 2.

Elevation-storage data, shown on sheet 9. Calculations for normal storage were reviewed and judged adequate. Flood water storage was determined from areas measured from the original reservoir plan.

Elevation-discharge data, shown on sheets 9 & 11. The discharge was estimated for both design and existing conditions.

$Q = C L H^{3/2}$ - when weir controls spillway discharge

L = 100 ft design, 90± ft effective. (See Photograph 15)

C p. 5-27, fig 5-18 design, fig 5-16 est. effective, King & Brater, Handbook of Hydraulics (6ed, 1976)

Water Surface	H	C	L	Q (design)	C	L	Q (est. exiting)
357	0		100	0		90	0
358	1	3.45	"	345 cfs ✓	3.44	"	310 cfs ✓
359	2	3.73	"	1055 ✓	3.42	"	871 ✓
360	3	3.87	"	2011 ✓	3.46	"	1618 ✓
361	4	3.88	"	3104 ✓	3.50	"	2520 ✓
362	5	"	"	4338 ✓	"	"	3522 ✓
365	8	"	"	8779 ✓	"	"	7128 ✓

The original design checked the hydraulic properties of the transition section by the energy equation for Q=3420 cfs. The upstream elevation was indicated to be 358.7 ft, above the level of the weir. No allowance was made for the submerged weir condition. The control section of the trough is at the downstream edge of the bridge, where the discharge passes thru critical conditions. The depth of water at the upper end is estimated by conservation of linear momentum

$$F_x = \frac{\gamma}{2} h_1^2 - \frac{\gamma}{2} h_2^2 = (v_x \rho q)_2 - (v_x \rho q)_1 \approx 0$$

$$h_1^2 = h_2^2 + \left(\frac{2 v_x q}{g}\right)_2$$

$q = Q/b$ where $b = 15$ ft

$h_2 = d_c$ & $v_x = v_c$

$d_c = (q^2/g)^{1/3}$ & $v_c = q/d_c$

Q = 2011 cfs

$q = 134.1$ cfs/ft $h_2 = 8.2$ ft $v_c = 16.3$ ft/sec

$$h_1^2 = 8.2^2 + \frac{2 \cdot 16.3 \cdot 134.1}{g}$$

$h_1 = 14.3$ ft

elev. of water surface ~ $h_1 + 341.5$ (elev. of channel at control)
= 355.8 ft OK

Q = 3104 cfs

$q = 206.9$ cfs/ft $h_2 = 11.0$ ft $v_c = 18.8$ ft/sec

$$h_1^2 = 11^2 + \frac{2 \cdot 18.8 \cdot 206.9}{g}$$

= 19.0 ft

W.S. = 360.5 ft above weir crest
(below underside of bridge ~360.9 ft)

estimate reservoir water surface using fig 5-5, King & Brater

Q = 3104 $Q_1 = 3.88 \cdot 100\ H_1^{3/2}$ design conditions

$H_2 = 360.5 - 357 = 3.5$

if $H_1 = 5$ ft, then $Q_1 = 4338$ cfs

$\frac{3104}{4338} = 0.715$ $\frac{H_2}{H_1} = 0.69$ from fig 5-5

$\frac{3.5}{5.0} = 0.7 \sim 0.69$ close enough.

reservoir water surface ~ 362 (357+5)

MEB DATE 2/22/80 SUBJECT Christman Dam Hydrology / Hydraulics SHEET 6 OF 12

CKD. BY [illegible] DATE 2/25/80 JOB No.

Estimated spillway discharge

elev	design Q	existing Q
357	0	0
358	345	310
359	1055	871
360	2011	1618
361		
362	3104	
362.5		3104

once overtopping begins, assume spillway discharge does not increase significantly, say Q = 3200 at 365.

Spillway adequacy -
As the spillway passes about 0.88 PMF under design conditions and about 0.59 PMF under existing conditions, the spillway is considered adequate.

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 80/02/15.
TIME= 05.43.01.

CHRISTMAN DAM
NAT ID NO. PA 00721 DER NO. 6-460
OVERTOPPING ANALYSIS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
200	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LKOPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= .50 .60 .80 1.00

SHEET 7 OF 12

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
IN	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.30	0.00	2.30	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.00	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 2.67 CP= .40 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 2.67 HOURS, CP= .40 VOL= .99

6.	21.	44.	71.	101.	133.	163.	189.	209.	222.
227.	221.	210.	200.	190.	181.	172.	164.	156.	148.
141.	134.	128.	122.	116.	110.	105.	100.	95.	90.
86.	82.	78.	74.	70.	67.	64.	61.	58.	55.
52.	50.	47.	45.	43.	41.	39.	37.	35.	33.
32.	30.	29.	27.	26.	25.	24.	22.	21.	20.
19.	18.	17.	17.	16.	15.	14.	14.	13.	12.
12.	11.	11.	10.	10.	9.	9.	8.	8.	7.
7.	7.	6.	6.	6.	6.	5.	5.	5.	5.
4.	4.	4.	4.	4.	3.	3.	3.	3.	3.

SHEET 8 OF 12

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH - DESIGN CONDITIONS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-357.	-1

STAGE	357.00	358.00	359.00	360.00	362.00	365.00
FLOW	0.00	345.00	1055.00	2011.00	3104.00	3200.00
CAPACITY=	3.	21.	63.	132.	234.	303. 422.
ELEVATION=	340.	345.	350.	355.	357.	360. 365.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
357.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
362.0	0.0	0.0	0.

CREST LENGTH	380.	630.	655.
AT OR BELOW ELEVATION	362.0	363.0	364.0

PEAK OUTFLOW IS 1835. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 2179. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 2888. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 3685. AT TIME 42.75 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

Design Conditions

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .50	RATIO 2 .60	RATIO 3 .80	RATIO 4 1.00
HYDROGRAPH AT	IN	2.30	1	1852.	2223.	2964.	3705.
	(	5.96)	(	52.45)(	62.94)(	83.92)(	104.90)(
ROUTED TO	OUT	2.30	1	1835.	2179.	2888.	3685.
	(	5.96)	(	51.97)(	61.70)(	81.77)(	104.36)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	357.00	357.00	362.00
STORAGE	234.	234.	350.
OUTFLOW	0.	0.	3104.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	359.82	0.00	298.	1835.	0.00	42.75	0.00
.60	360.31	0.00	310.	2179.	0.00	43.00	0.00
.80	361.60	0.00	341.	2888.	0.00	43.00	0.00
1.00	362.56	.56	364.	3685.	2.75	42.75	0.00

SHEET 10 OF 12

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH - EXISTING CONDITIONS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-357.	-1

STAGE	357.00	358.00	359.00	360.00	362.50	365.00
FLOW	0.00	310.00	871.00	1618.00	3104.00	3200.00
CAPACITY=	3.	21.	63.	132.	234.	303. 422.
ELEVATION=	340.	345.	350.	355.	357.	360. 365.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
357.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
360.8	0.0	0.0	0.

CREST LENGTH AT OR BELOW ELEVATION	0.	285.	380.	630.	655.
	360.8	361.5	362.0	363.0	364.0

PEAK OUTFLOW IS 1815. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 2175. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 2951. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 3693. AT TIME 42.75 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

EXISTING CONDITIONS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .50	RATIO 2 .60	RATIO 3 .80	RATIO 4 1.00
HYDROGRAPH AT	IN	2.30	1	1852.	2223.	2964.	3705.
	(	5.96)	(	52.45)(	62.94)(	83.92)(	104.90)(
ROUTED TO	OUT	2.30	1	1815.	2175.	2951.	3693.
	(	5.96)	(	51.39)(	61.60)(	83.56)(	104.56)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

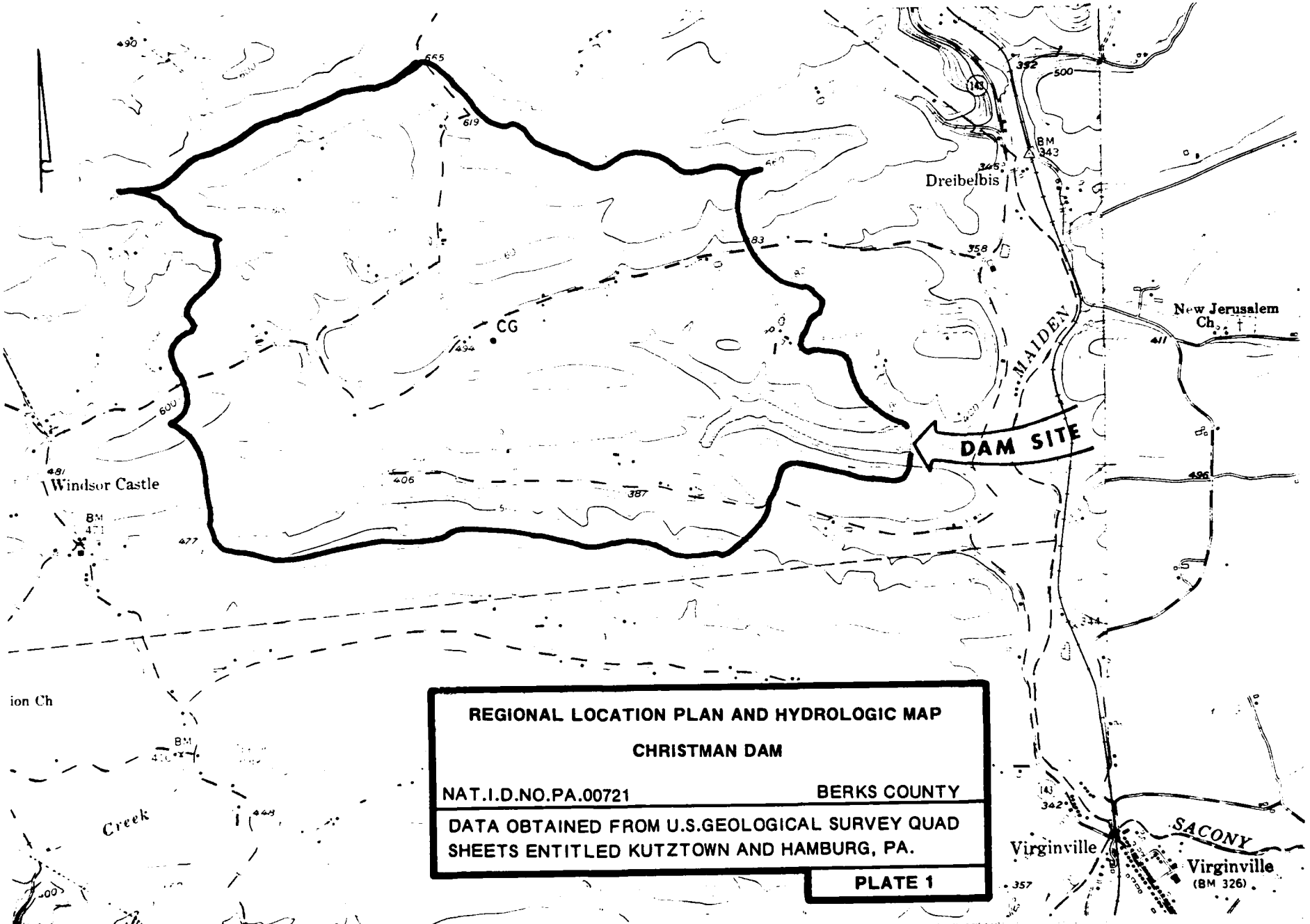
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	357.00	357.00	360.80
STORAGE	234.	234.	322.
OUTFLOW	0.	0.	2094.

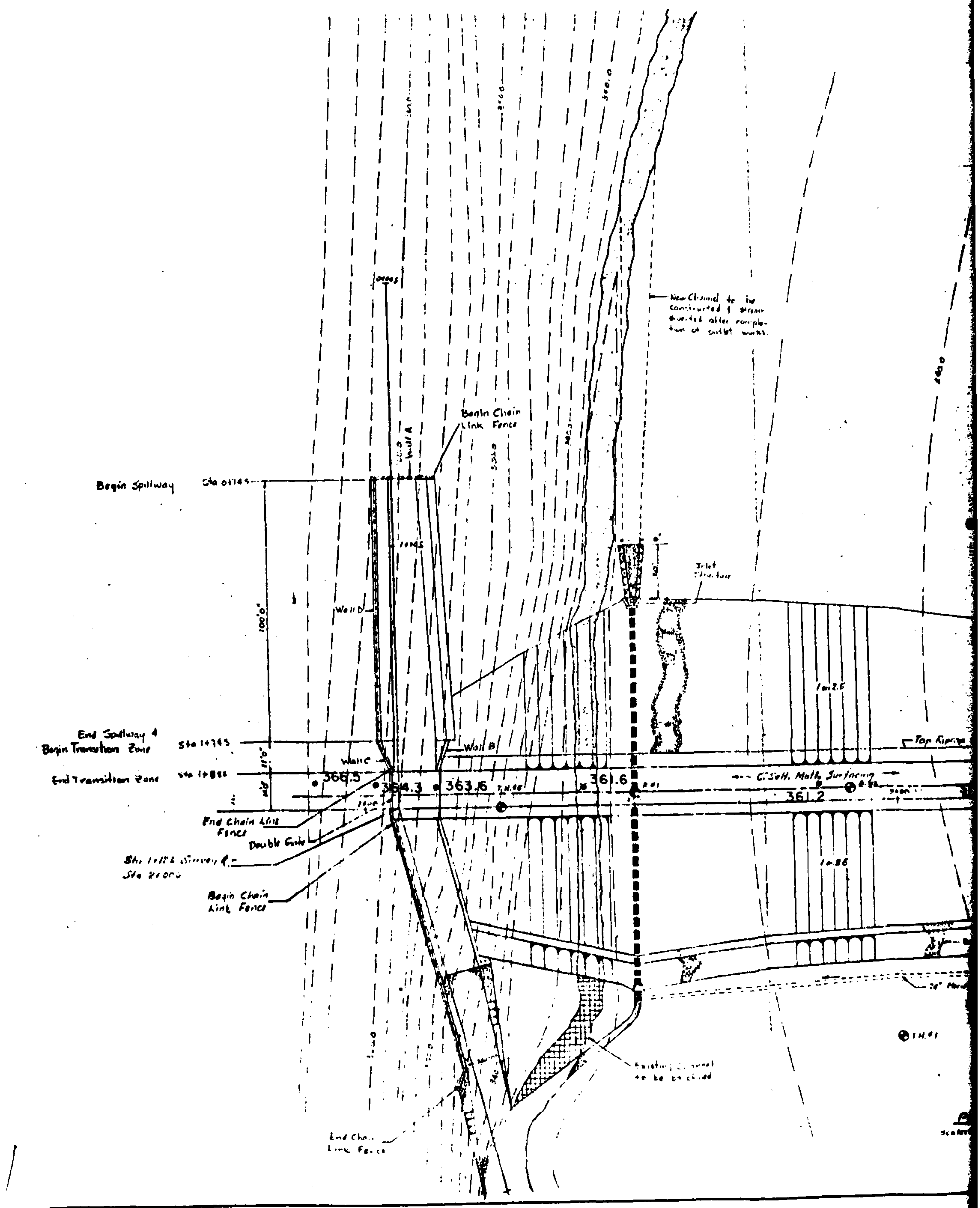
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	360.33	0.00	311.	1815.	0.00	43.00	0.00
.60	360.93	.13	325.	2175.	1.50	43.00	0.00
.80	361.67	.87	343.	2951.	4.25	42.75	0.00
1.00	362.08	1.28	352.	3693.	6.25	42.75	0.00

SHEET 12 OF 12

APPENDIX

E


Dreibelbis
BM 343
New Jerusalem Ch.
MAIDEN
DAM SITE
CG
Windsor Castle
BM 471
Creek
Virginville
SACONY
Virginville (BM 326)
REGIONAL LOCATION PLAN AND HYDROLOGIC MAP
CHRISTMAN DAM
NAT.I.D.NO.PA.00721
BERKS COUNTY
DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEETS ENTITLED KUTZTOWN AND HAMBURG, PA.
PLATE 1


Begin Spillway
Begin Chain Link Fence
Wall A
Wall D
100'0"
End Spillway &
Begin Transition Zone
Wall B
Wall C
End Transition Zone
366.5
364.3
363.6
361.6
361.2
End Chain Link Fence
Double Gate
Begin Chain Link Fence
End Chain Link Fence
New Channel to be constructed & stream diverted after completion of outlet works.
Inlet Structure
1 on 2.5
Top Riprap
Existing Channel

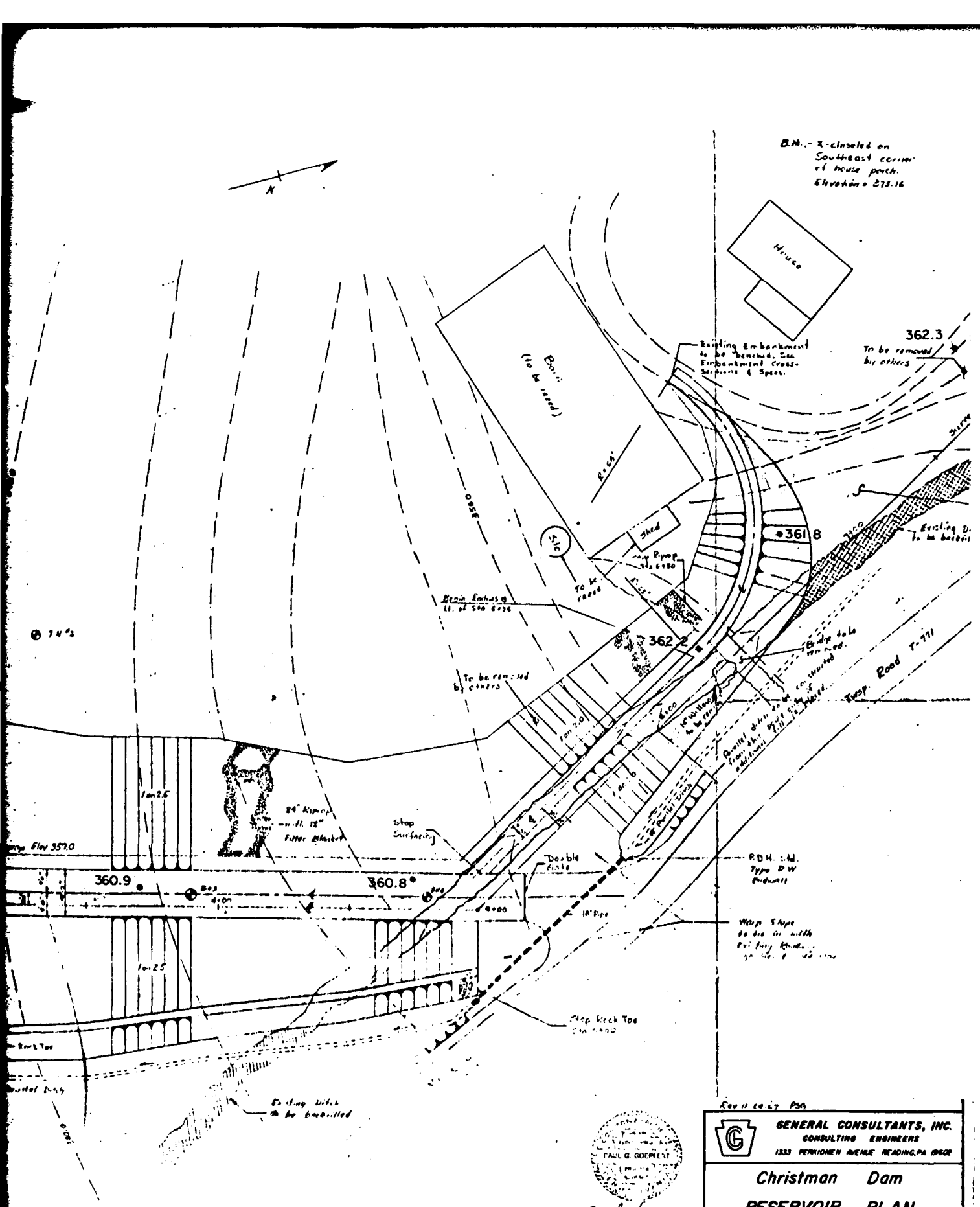
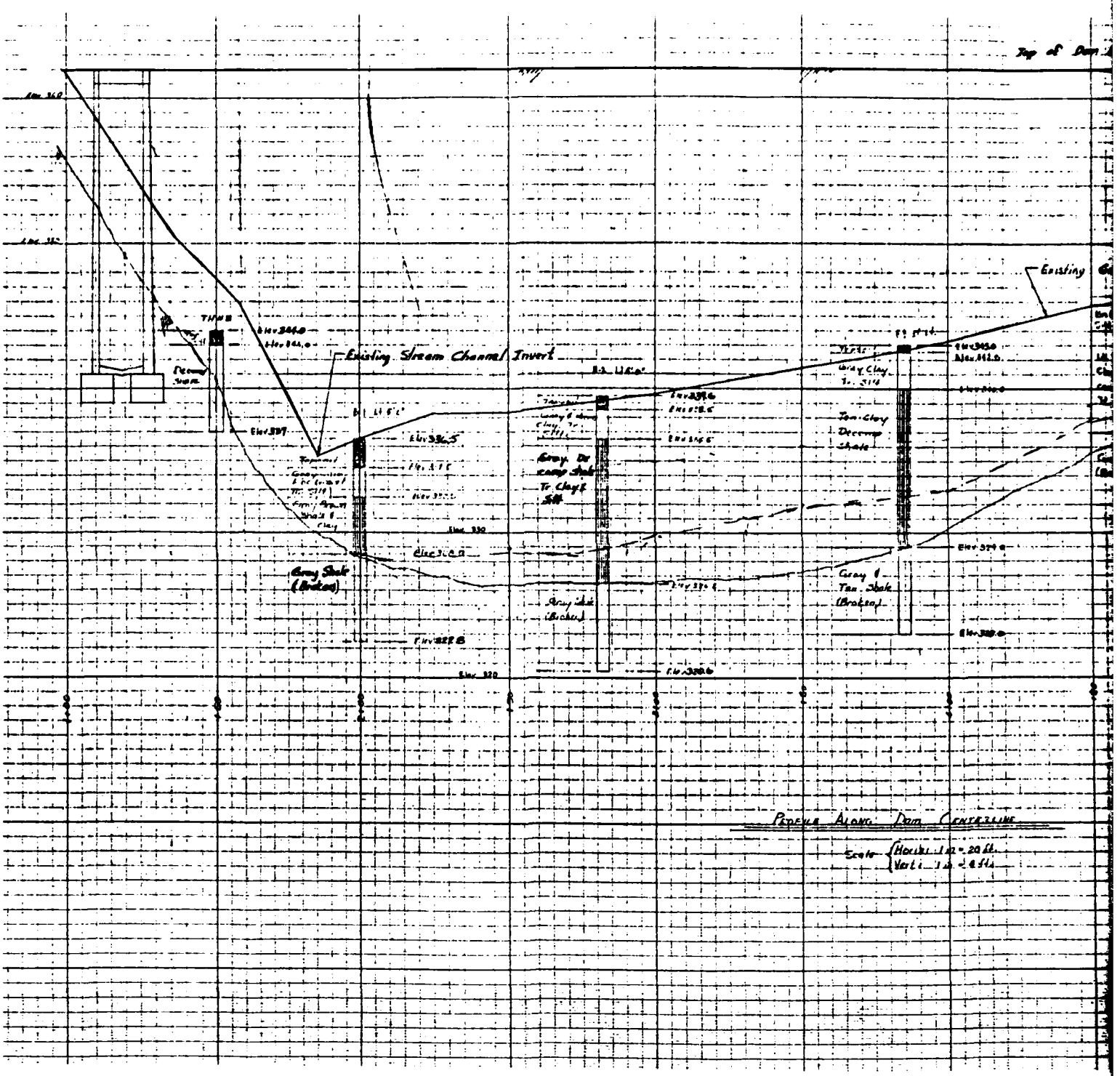
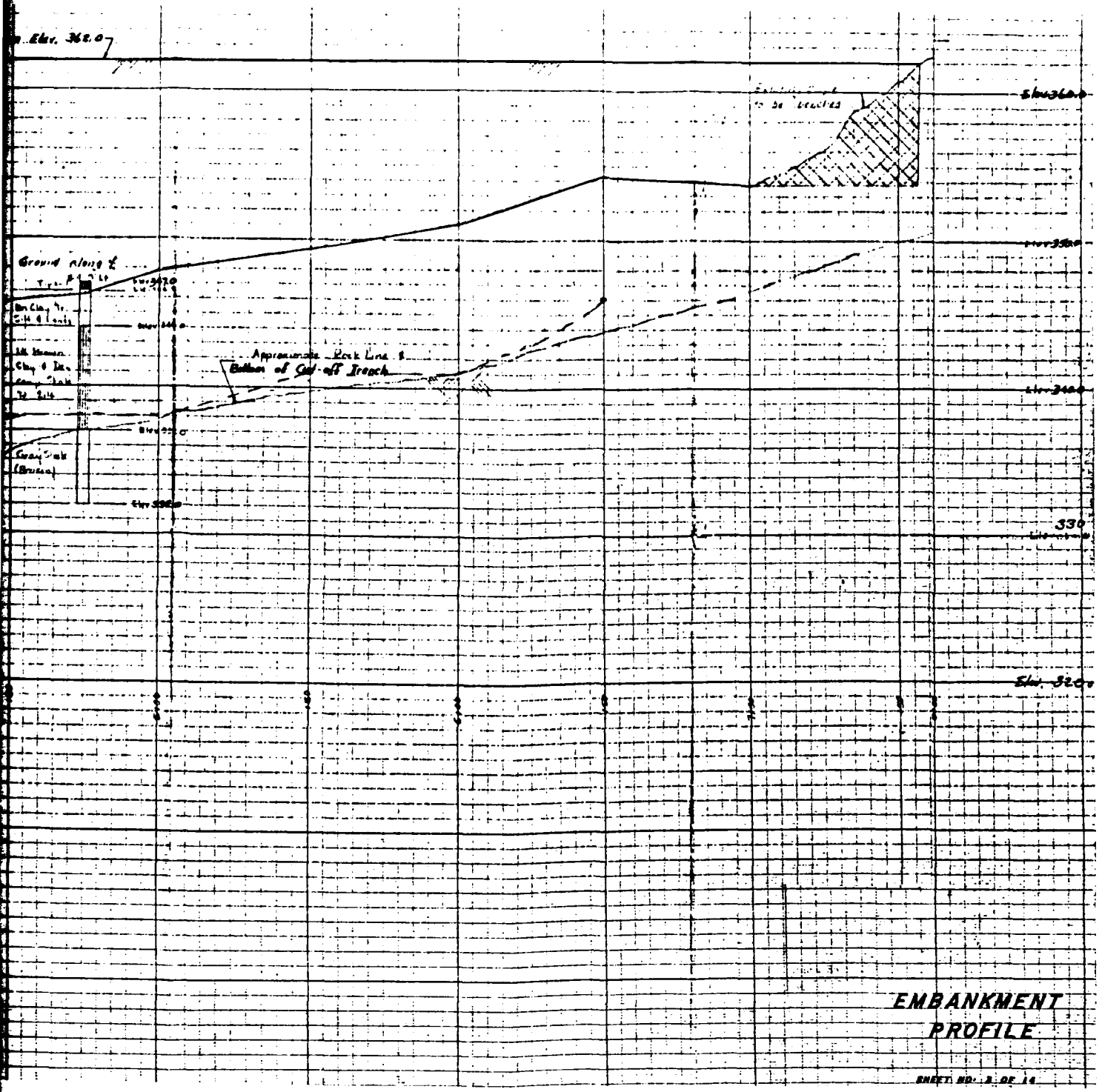

B.M. - X-chiseled on Southeast corner of house porch. Elevation = 378.16
N
House
362.3
To be removed by others
Existing Embankment to be benched. See Embankment Cross-Sections & Specs.
Basin (To be raised)
Shed
361.8
362.2
To be removed
To be removed by others
Bridge to be removed.
Twsp. Road T-971
Stop Surfacing
Double Fence
P.D.H. Inl. Type D-W Bridwell
Warp Slope to tie in with
Stop Keck Toe
Existing Ditch to be backfilled
360.9
360.8
Rock Toe
Outlet Pipe
SPOT ELEVATIONS TAKEN ON NOV. 21, 1979
PLAN
GENERAL CONSULTANTS, INC.
CONSULTING ENGINEERS
1333 PERKIOMEN AVENUE READING, PA 19602
Christman Dam
RESERVOIR PLAN & CONTOURS
JOB NO 801-187-03
SCALE AS NOTED
DATE 8-21-'87
DRAWN BY P.G.G
CHECKED BY
SHEET NO 2 OF 14
PAUL G. GOEPFERT
Paul G. Goepfert

PLATE 2

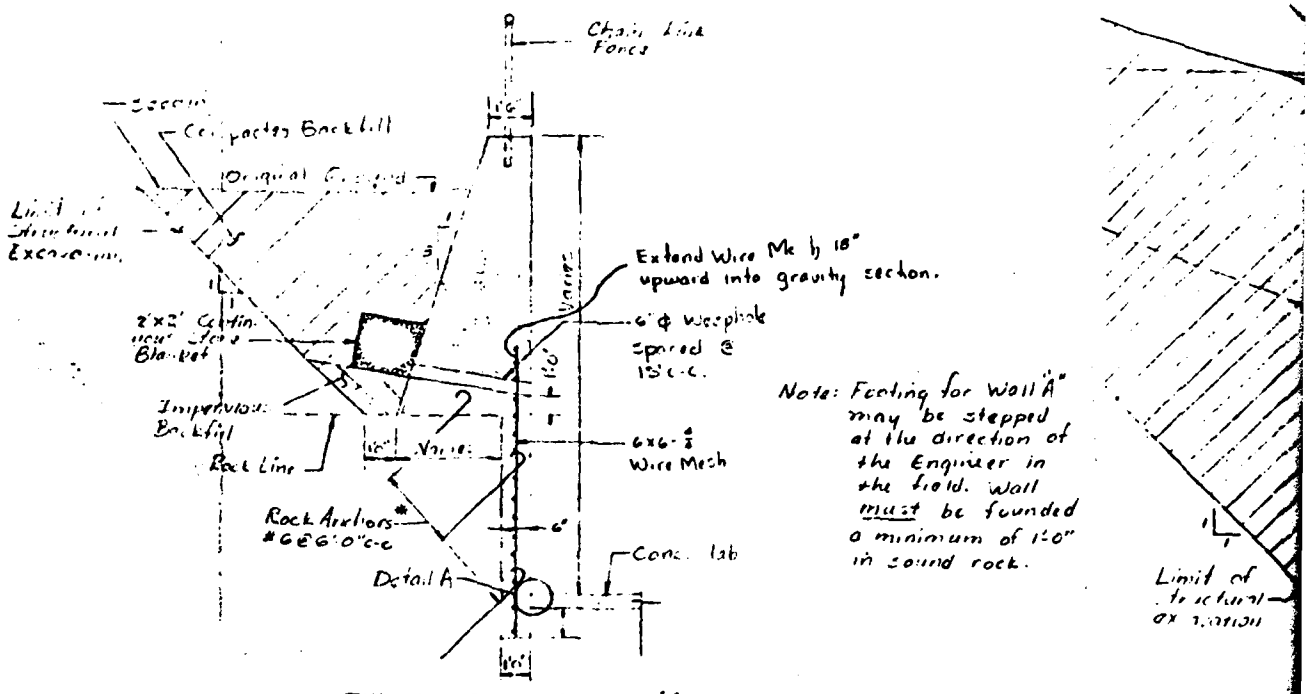

Top of Dam
Existing
Existing Stream Channel Invert
Gray Shale (Broken)
Gray Shale (Broken)
Gray & Tan Shale (Broken)
Gray Clay
Tan Clay Decomp Shale
Gray Decomp Shale Tr. Clay & Silt
Elev 339.0
Elev 330
Elev 320
PROFILE ALONG DAM CENTERLINE
Scale {Horiz. 1 in. = 20 ft.
Vert. 1 in. = 4 ft.



EMBANKMENT PROFILE

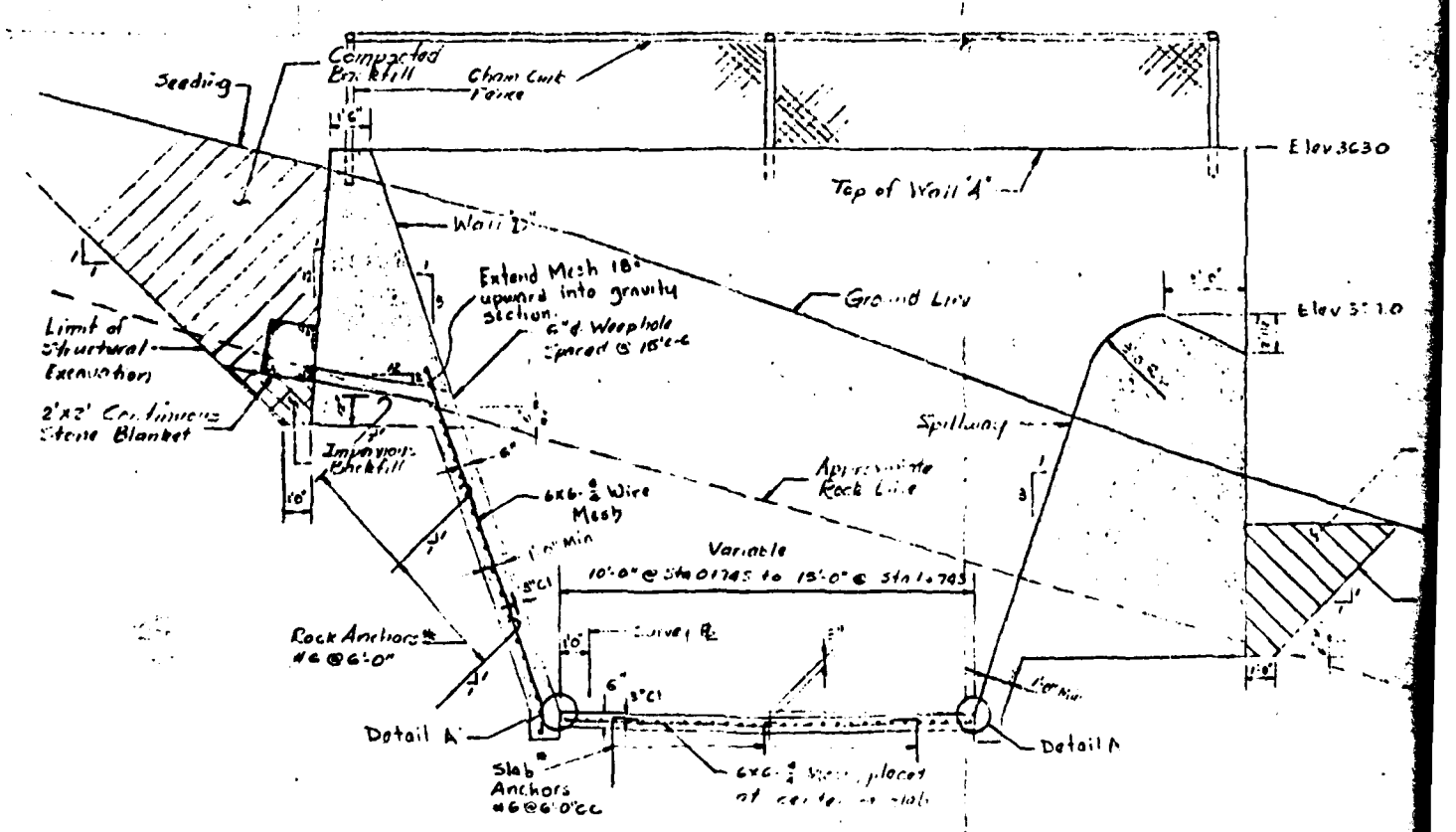
SHEET NO. 3 OF 14

PLATE 3



TYPICAL SECTION - WALL 'A'

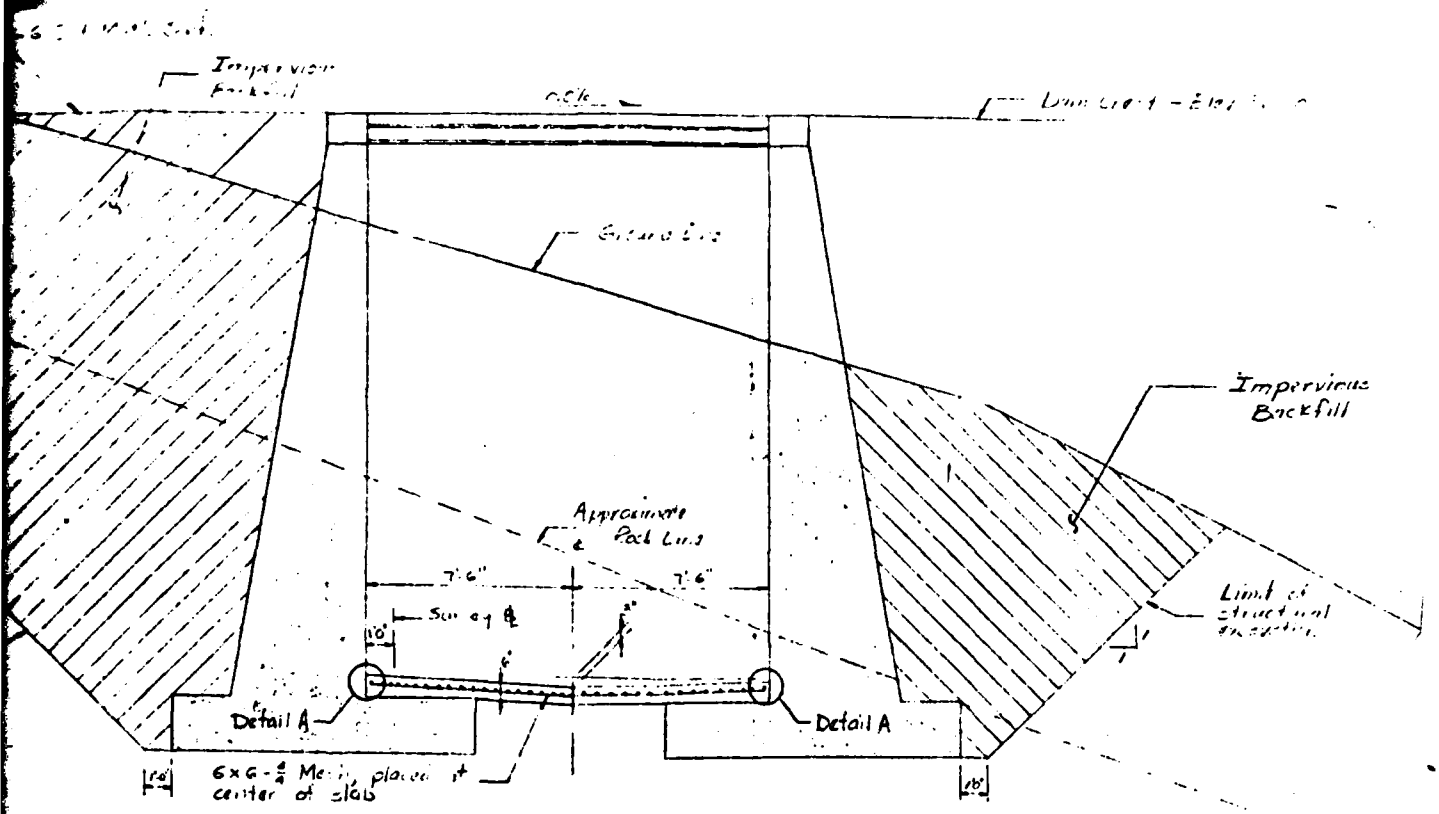
Scale: 1/4" = 1'-0"



TYPICAL SECTION

Sta 0+74[illegible] to Sta 1+70[illegible]

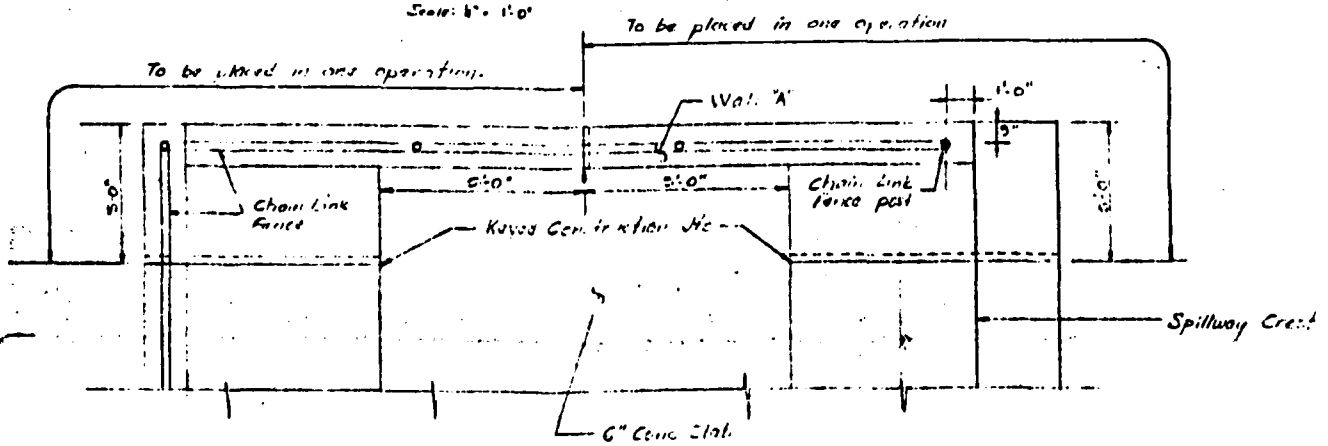
No Scale



TYPICAL SECTION

Sta 1+85 to 1+[illegible]

Scale: 1/4" = 1'-0"



PLAN VIEW - WALL "A"

Scale: 1/4" = 1'-0"

Rev 11-24-67 PGG

COMMONWEALTH OF PENNSYLVANIA PROFESSIONAL ENGINEER PAUL G. GOEPFERT

Paul G. Goepfert

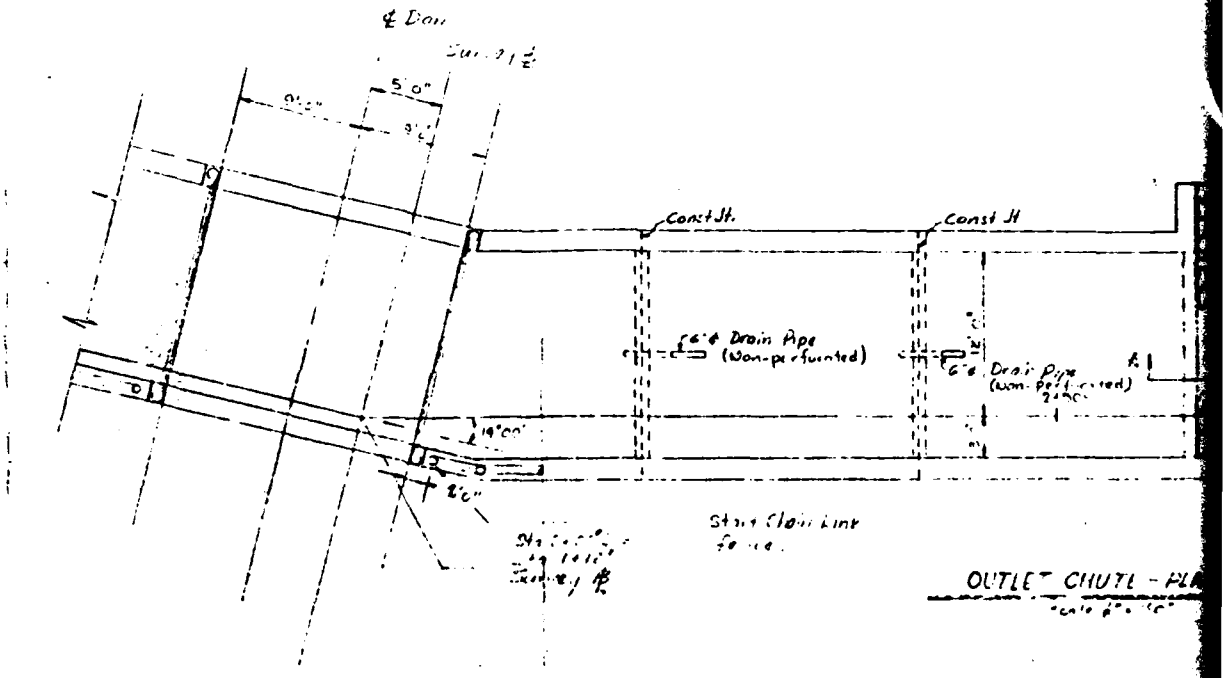
GENERAL CONSULTANTS, INC.
CONSULTING ENGINEERS
1333 PERKIOMEN AVENUE READING, PA 19602

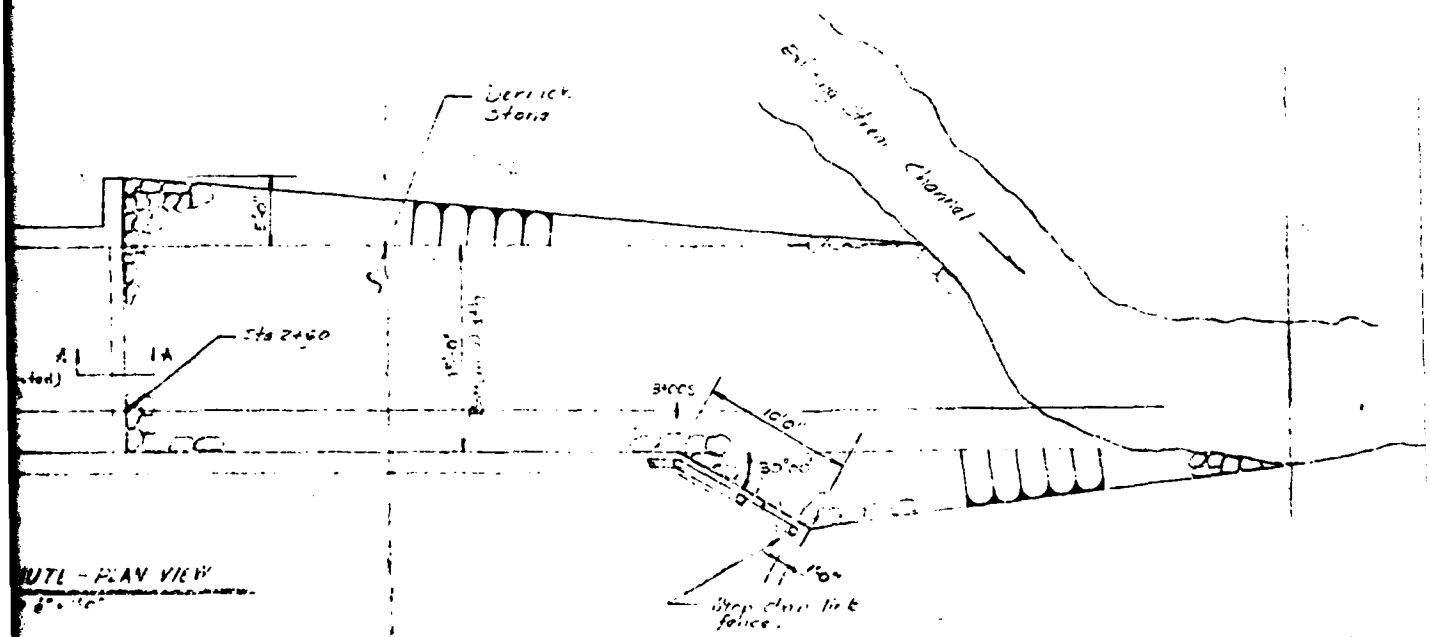
Christman Dam

SPILLWAY PLAN

JOB NO	SCALE AS NOTED	DRAWN BY P.G.G.	SHEET NO
GCI-167-03	DATE 9-21-'67	CHECKED BY	4 OF 14

PLATE 4


Const Jt.
Const Jt
6'-6" Drain Pipe (Non-perforated)
6'-6" Drain Pipe (Non-perforated)
Steel Chain Link
OUTLET CHUTE - PL



UTL - PLAN VIEW

GENERAL CONSULTANTS, INC.
CONSULTING ENGINEERS
1333 PERKIOMEN AVENUE READING, PA. 19602

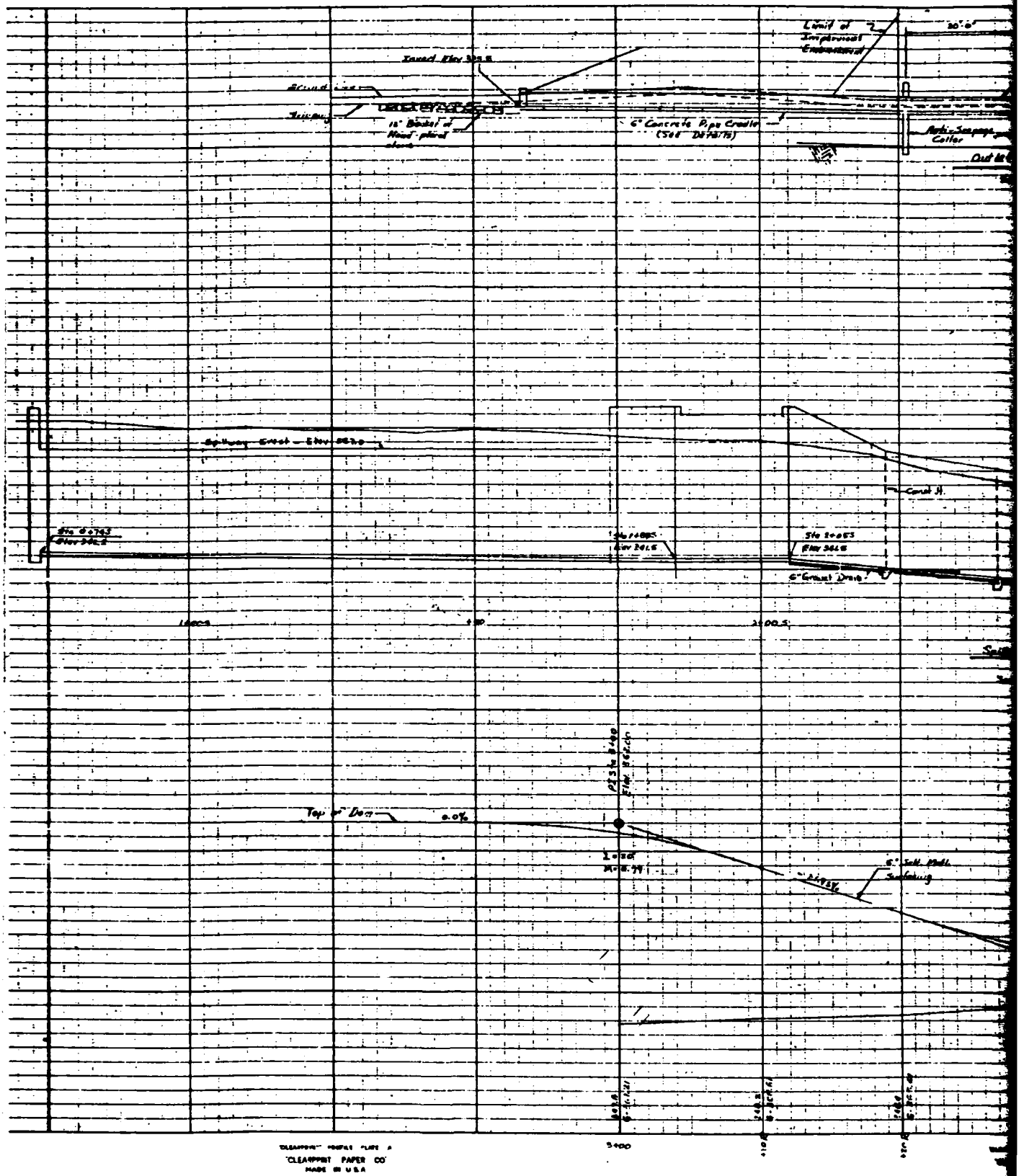
Christman Dam

SPILLWAY PLAN

JOB NO:	SCALE: AS NOTED	DRAWN BY: P.G.B.	SHEET NO:
GCI-167-03	DATE 9-21-'67.	CHECKED BY	5 OF 14

2

PLATE 5



"CLEARPRINT" PRINTED IN U.S.A.
"CLEARPRINT PAPER CO"
MADE IN U.S.A.

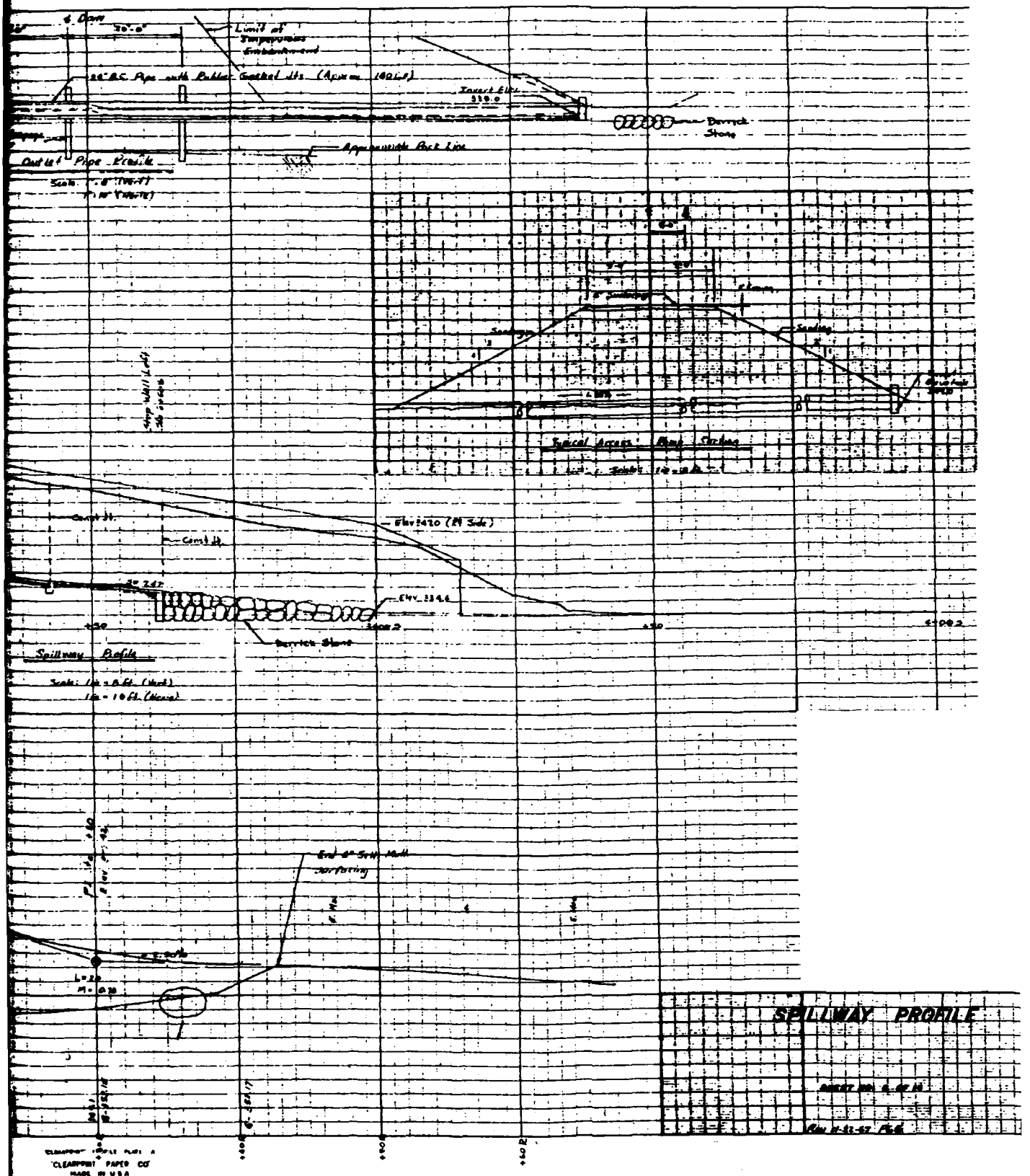
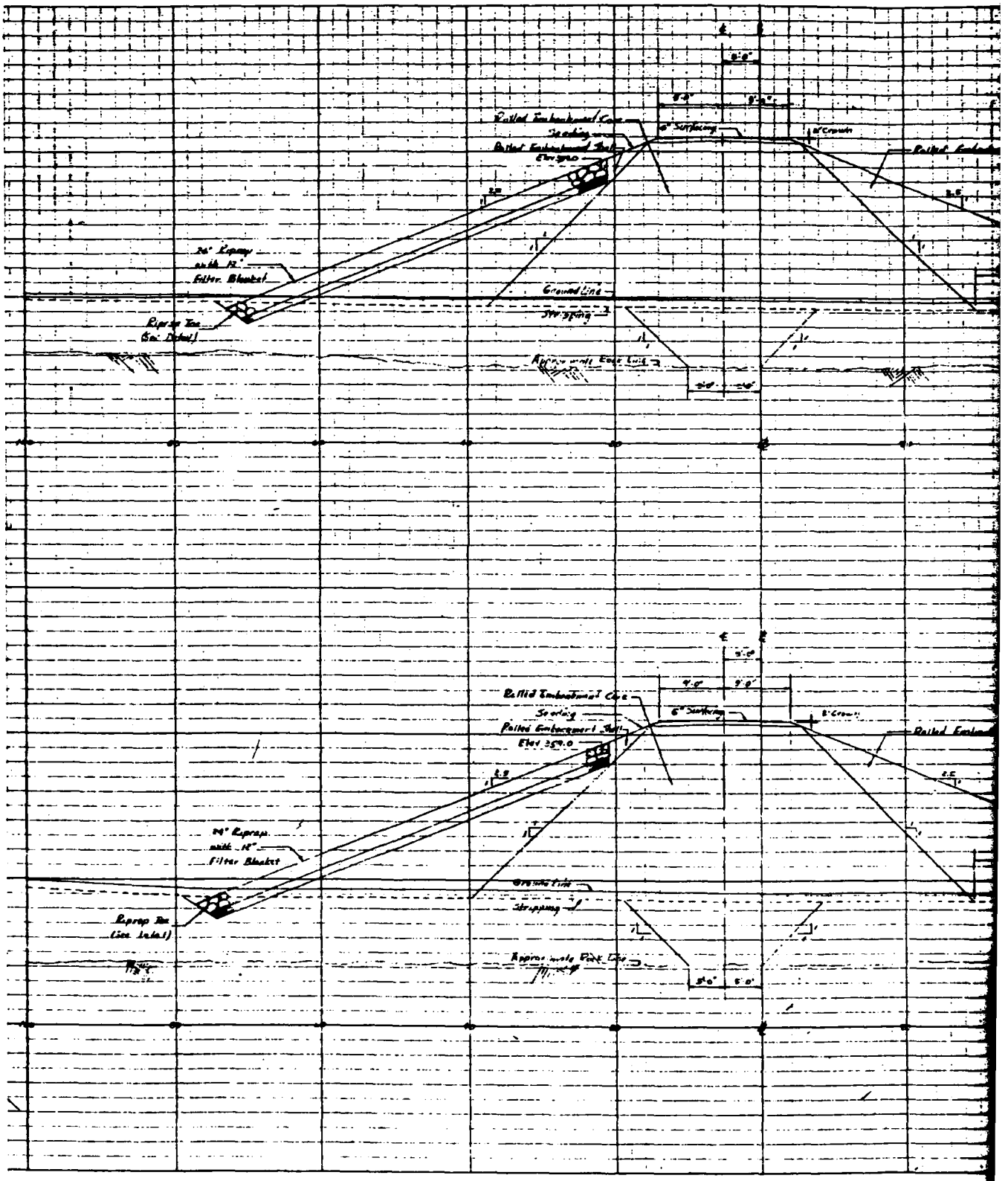
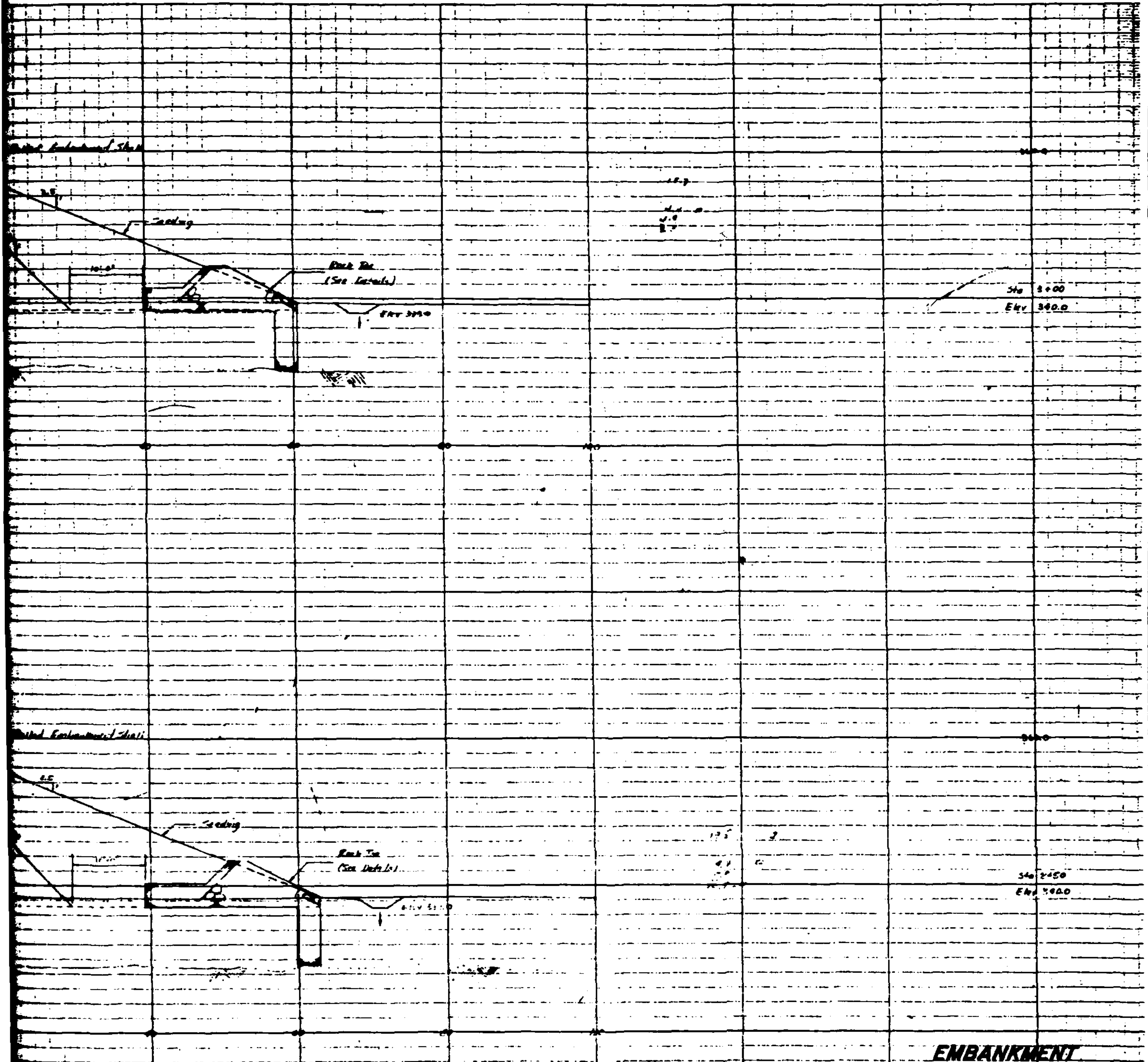

Limit of Impervious Embankment
Outlet Pipe Profile
Spillway Profile
Typical Access Ramp Section
Elev 1470 (Rt Side)
Elev 1334.6
Service Stone
End of Soil Mulch Surfacing
SPILLWAY PROFILE
ACCESS RAMP PROFILE

PLATE 6

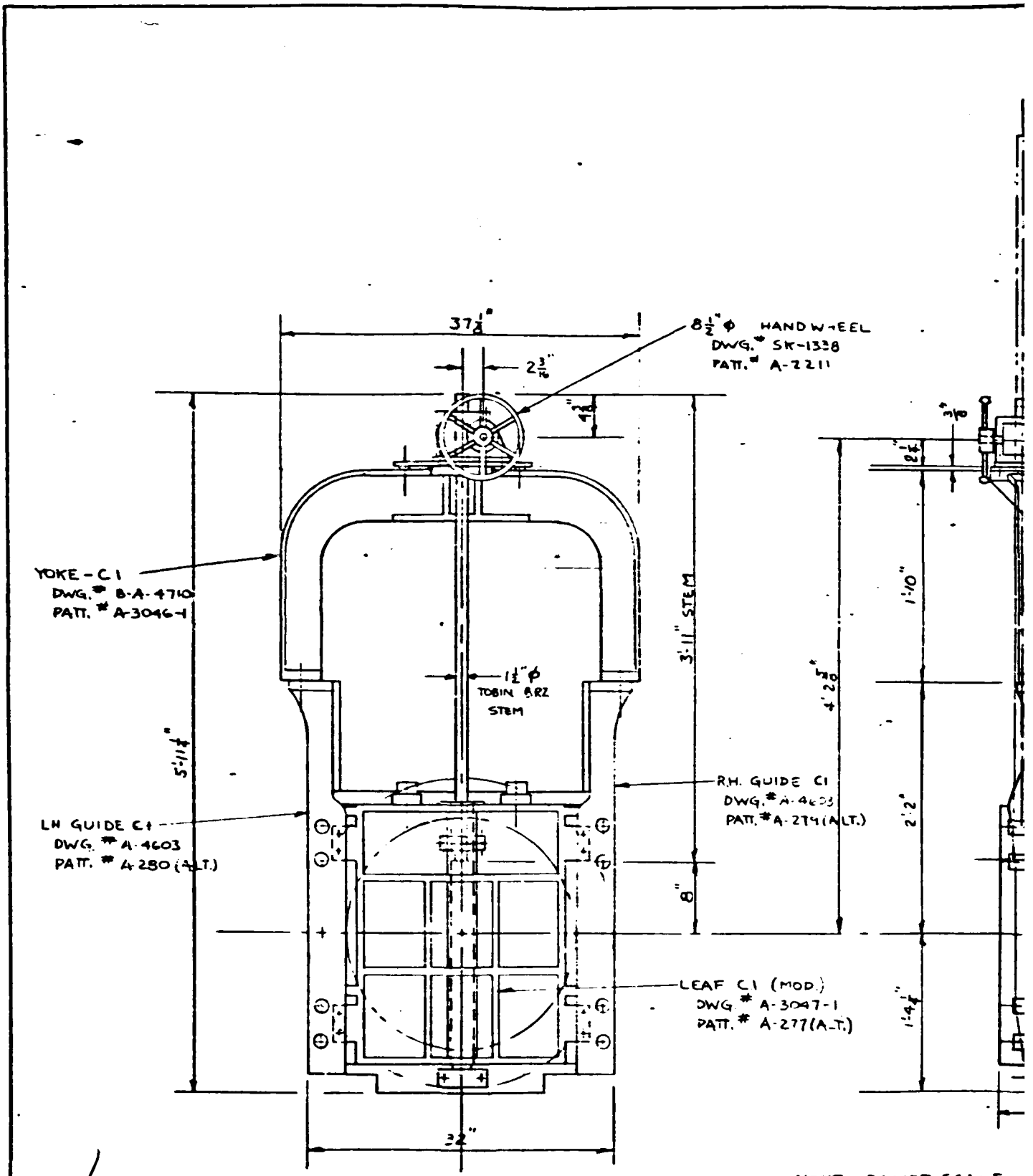


6-460=10
FILE NUMBER
RECEIVED IN THE ... OF THE WATER & POWER RESOURCES BOARD, DEPARTMENT OF FORESTS & WATERS ON THE ... DAY OF ... A.D. 19..



EMBANKMENT CROSS-SECTIONS

SHEET NO. 10 OF 14

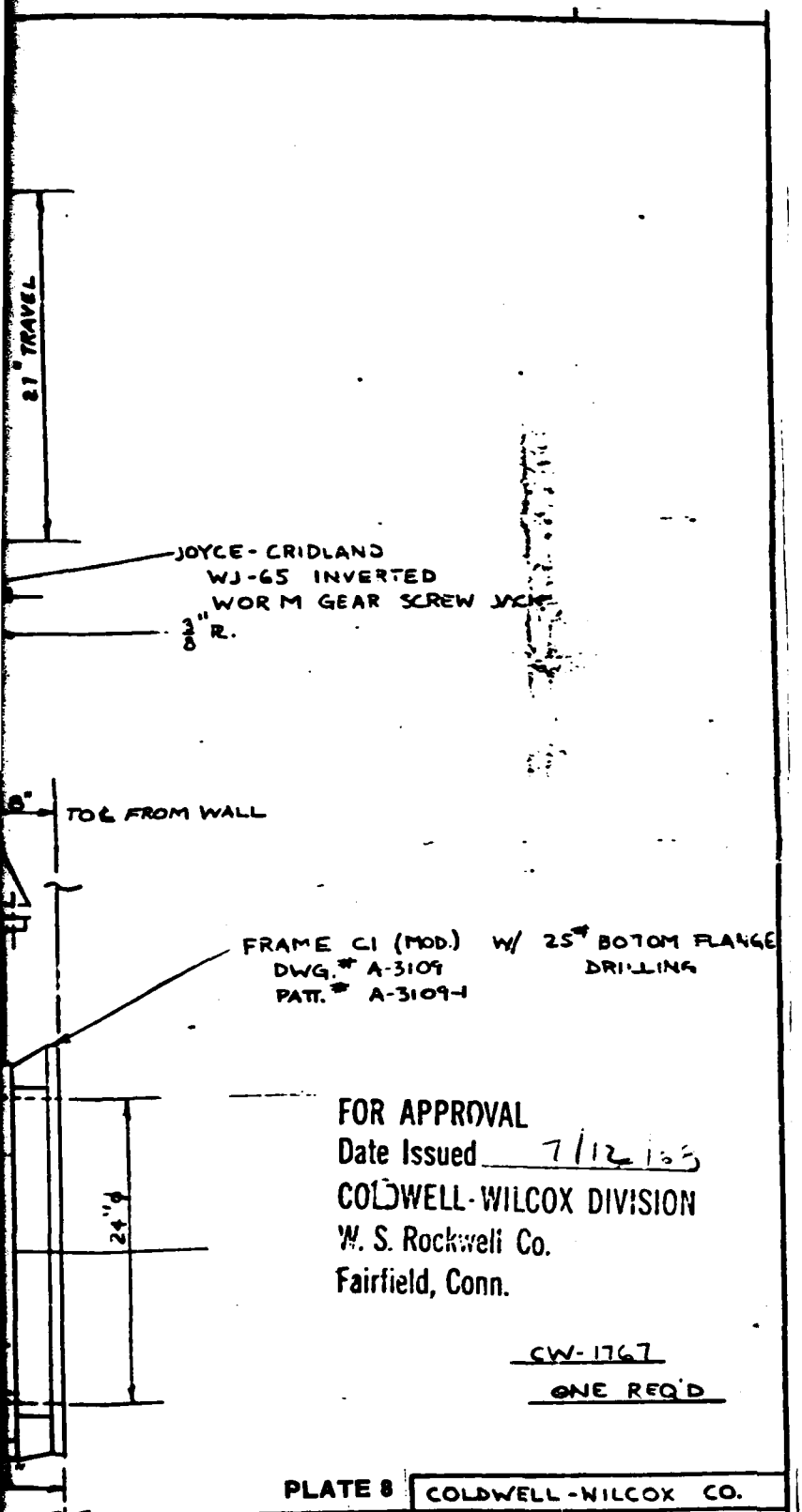


NOTE - DONOT SCALE
DRAWING. REF-

AD-A085 266 WOODWARD-CLYDE CONSULTANTS PLYMOUTH MEETING PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. CHRISTMAN DAM (NDS I.D. NUMBER--ETC(U)
MAR 80 M F BECK, J H FREDERICK DACW31-80-C-0018
UNCLASSIFIED NL

2 OF 2
AD
A085 266

END
DATE FILMED
6-80
DTIC

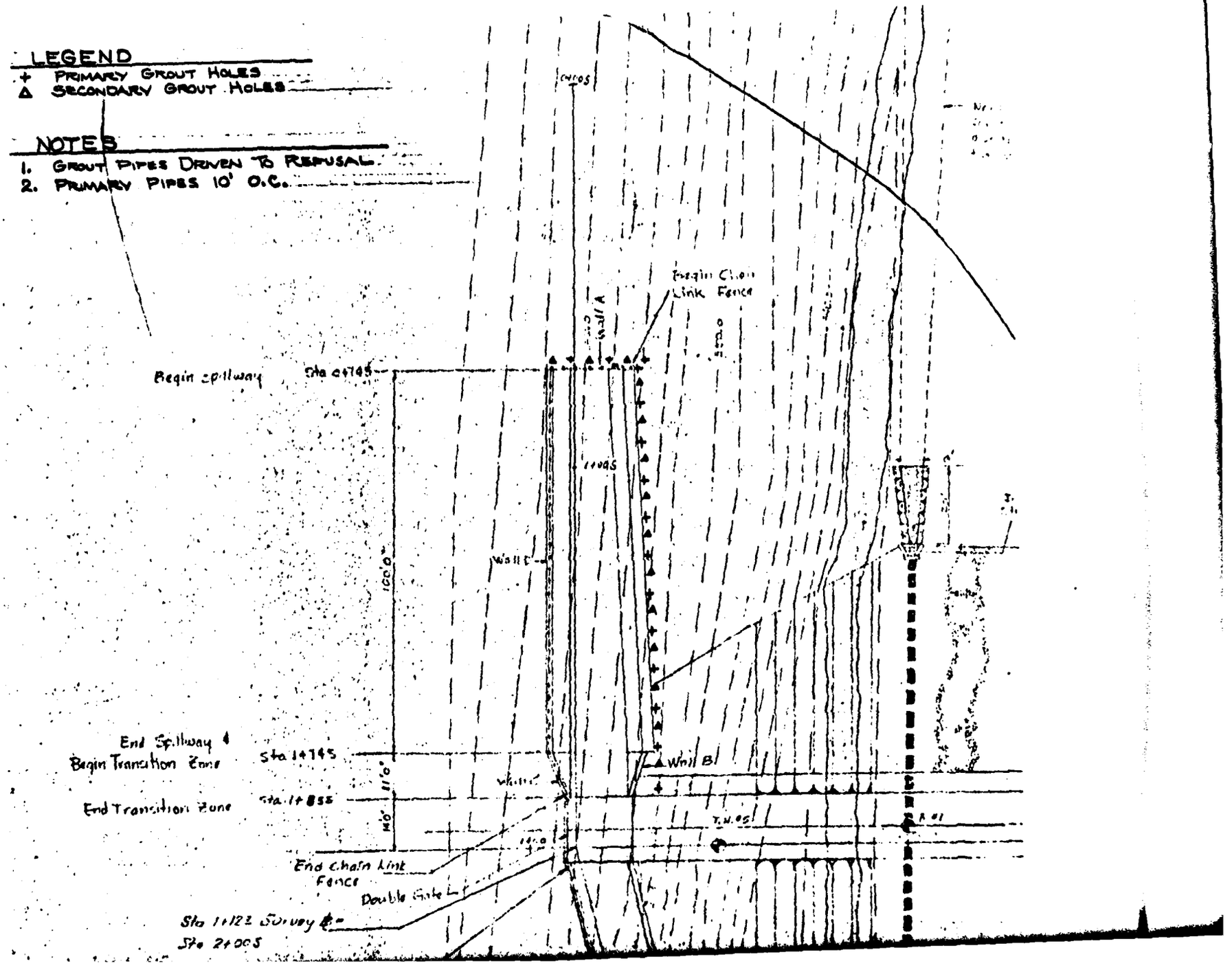


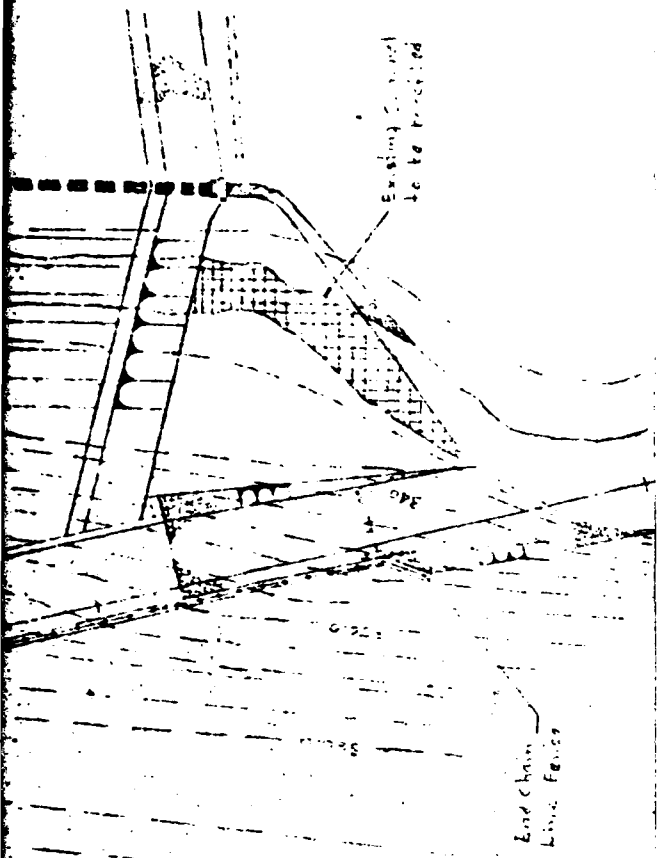
FOR APPROVAL
Date Issued 7/12/68
COLDWELL-WILCOX DIVISION
W. S. Rockwell Co.
Fairfield, Conn.

CW-1767
ONE REQ'D

PLATE 8

					COLDWELL-WILCOX CO.	
C				DATE 7-12-68	W. S. ROCKWELL CO. FAIRFIELD, CONN.	
B				SCALE	TITLE 24" SQ. TURD SLUICE GATE R.S.B.P. ST'D BOTT. SELF-CONT	
A				DRAWN KWER		
NO.	REVISIONS	BY	DATE	CHECKED	MATERIAL	DRAWING NO. C-SP-762


LEGEND
+ PRIMARY GROUT HOLES
Δ SECONDARY GROUT HOLES
NOTES
1. GROUT PIPES DRIVEN TO REFUSAL.
2. PRIMARY PIPES 10' O.C.
Begin Chain Link Fence
Begin spillway
Sta 0+745
Wall A
Wall B
100'0
End Spillway &
Begin Transition Zone
Sta 1+745
End Transition Zone
Sta 1+855
110'
40'
End chain link Fence
Double Gate
Sta 1+122 Survey ℄
Sta 2+005



GENERAL CONSULTANTS, INC.
CONSULTING ENGINEERS
1333 PERKIOMEN AVENUE READING, PA. 19602

Christman Dam

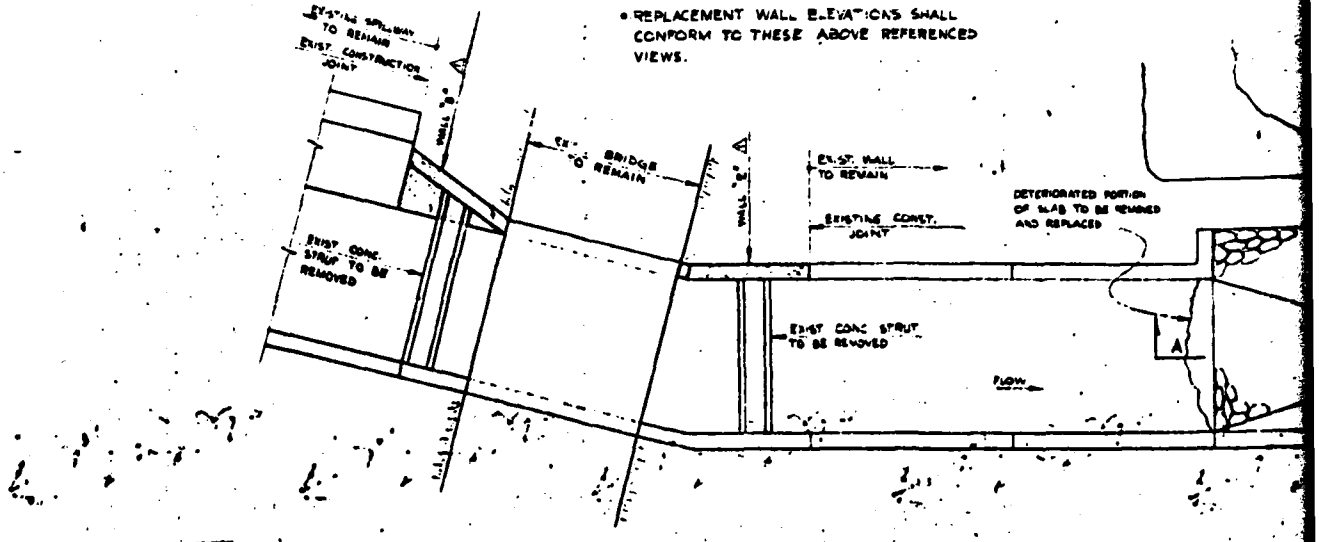
RESERVOIR PLAN & CONTOURS

JOB NO	SCALE AS NOTED	DRAWN P.G.G.	SHEET NO.
GCI-167-03	DATE 9-21-'67	CHECKED BY	2 OF 14

PLATE 9

NOTE: ⚠

- FOR ELEVATION VIEW OF WALL "B", SEE SHEET 4 OF 14 OF ORIGINAL DESIGN DRAWINGS, DATED 9-21-67.
- FOR ELEVATION VIEW OF WALL "E" SEE SHEET 6 OF 14 OF ORIGINAL DESIGN DRAWINGS, DATED 9-21-67.
- REPLACEMENT WALL ELEVATIONS SHALL CONFORM TO THESE ABOVE REFERENCED VIEWS.



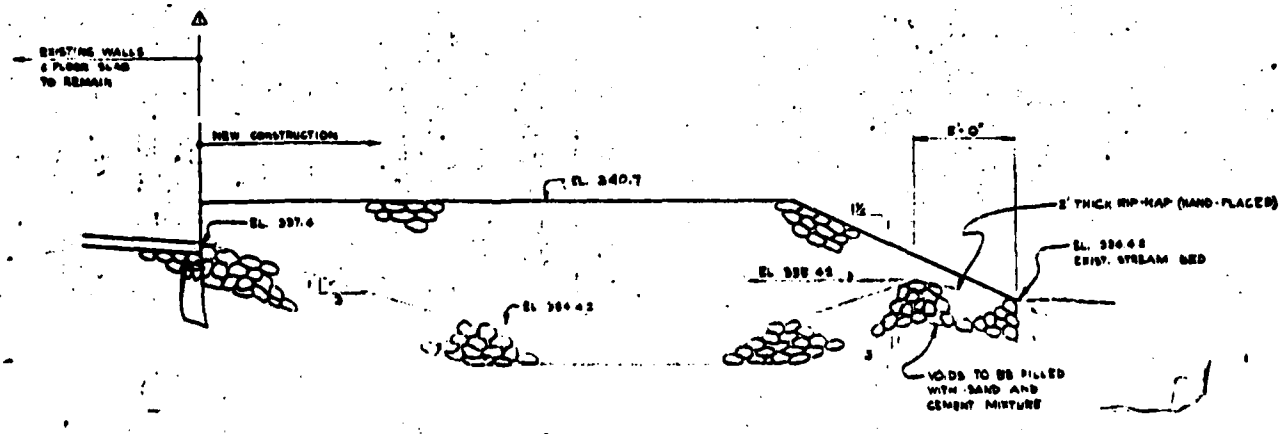
PLAN

SCALE · 1/8" = 1'-0"

⚠ DENOTES PORTION OF EXISTING WALL TO BE REMOVED AND REPLACED (SEE WALL SECTION THIS SHEET, FOR REPLACEMENT WALL CONFIGURATION.) ⚠

GE

1. REMOVE CONCRE
2. EXPOSE UNDERC
3. DETERIO WITH R



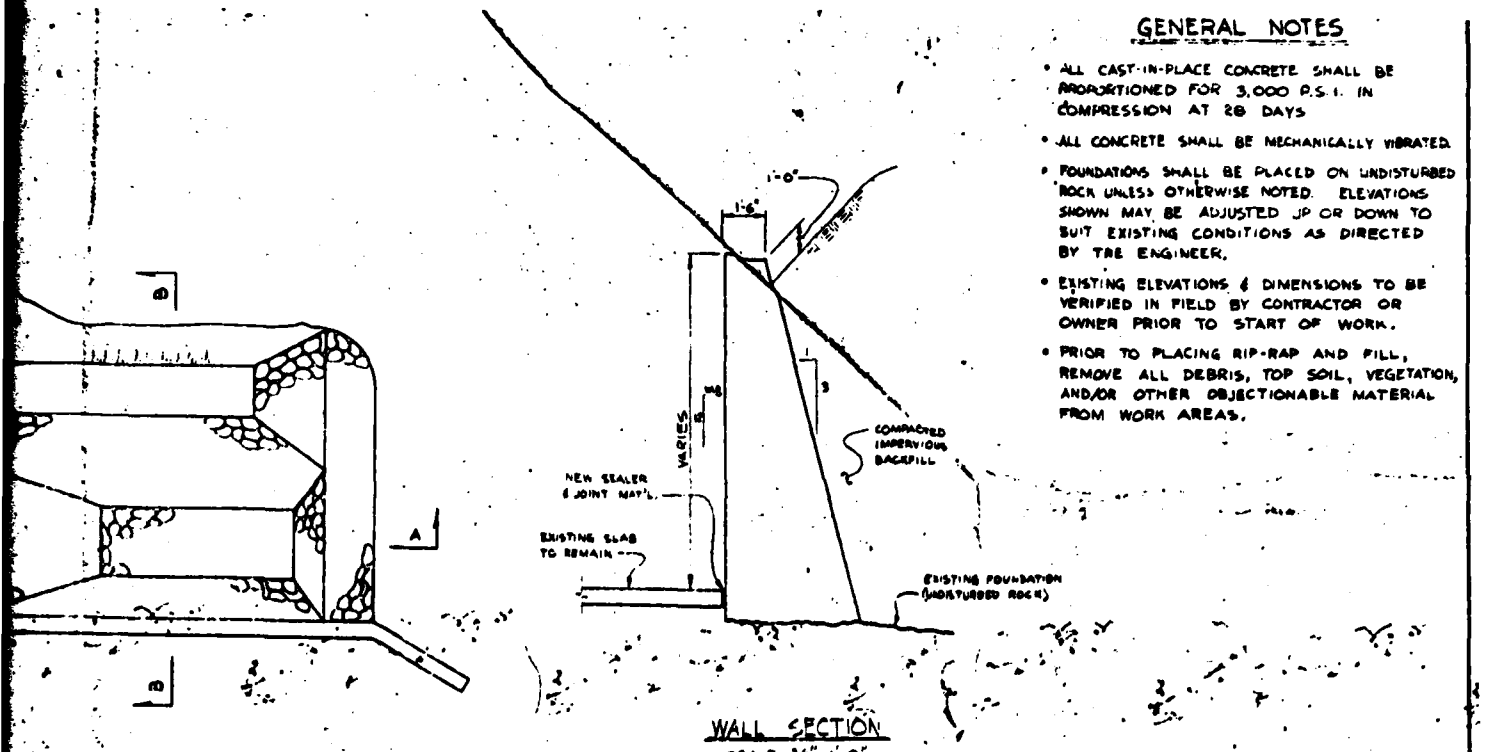
SECTION A-A

SCALE ¼" = 1'-0"

10-24-78 ADDED NOTES.			

GENERAL NOTES

- ALL CAST-IN-PLACE CONCRETE SHALL BE PROPORTIONED FOR 3,000 P.S.I. IN COMPRESSION AT 28 DAYS
- ALL CONCRETE SHALL BE MECHANICALLY VIBRATED.
- FOUNDATIONS SHALL BE PLACED ON UNDISTURBED ROCK UNLESS OTHERWISE NOTED. ELEVATIONS SHOWN MAY BE ADJUSTED UP OR DOWN TO SUIT EXISTING CONDITIONS AS DIRECTED BY THE ENGINEER.
- EXISTING ELEVATIONS & DIMENSIONS TO BE VERIFIED IN FIELD BY CONTRACTOR OR OWNER PRIOR TO START OF WORK.
- PRIOR TO PLACING RIP-RAP AND FILL, REMOVE ALL DEBRIS, TOP SOIL, VEGETATION, AND/OR OTHER OBJECTIONABLE MATERIAL FROM WORK AREAS.



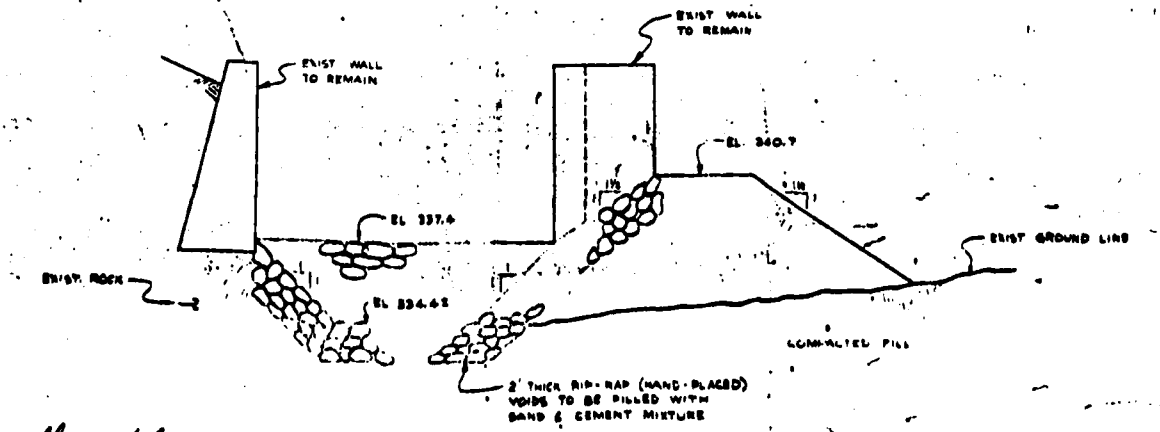
WALL SECTION
SCALE: 3/8" = 1'-0"

GENERAL WALL REPAIRS

OVE DETERIORATED CONCRETE TO SOUND CRETE (SQUARE-CUT ENDS).

OSED REINFORCING SHALL BE ERCUT 1" TO SOUND CONCRETE.

ERIORATED CONCRETE SHALL BE REPLACED H PRESSURE MORTAR BUILD-UP.



SECTION B-B
SCALE: 1/4" = 1'-0"

Sec. A-A

① Cut off wall with weepholes under end of slab

② Copper wire screen behind weepholes

③ This sheet is new. If there are any changes on other sheets they should be marked.

④ It would be better if have fill go to top of walls & properly sealed to surface run off would not be trapped behind the walls.

⑤ No detail of vert. joints

PLATE 10

SPILLWAY AND RETAINING WALL REPAIRS
for
CHRISTMAN DAM
BERKS COUNTY PENNSYLVANIA

GENERAL DETAILS

CODE NO	DRAWN	DRAWING NO
C4425	J.J.D	12
DATE	CHECKED	
10-16-78	P.G.G	
SCALE	SHEET	
AS NOTED	1 OF 1	

APPENDIX

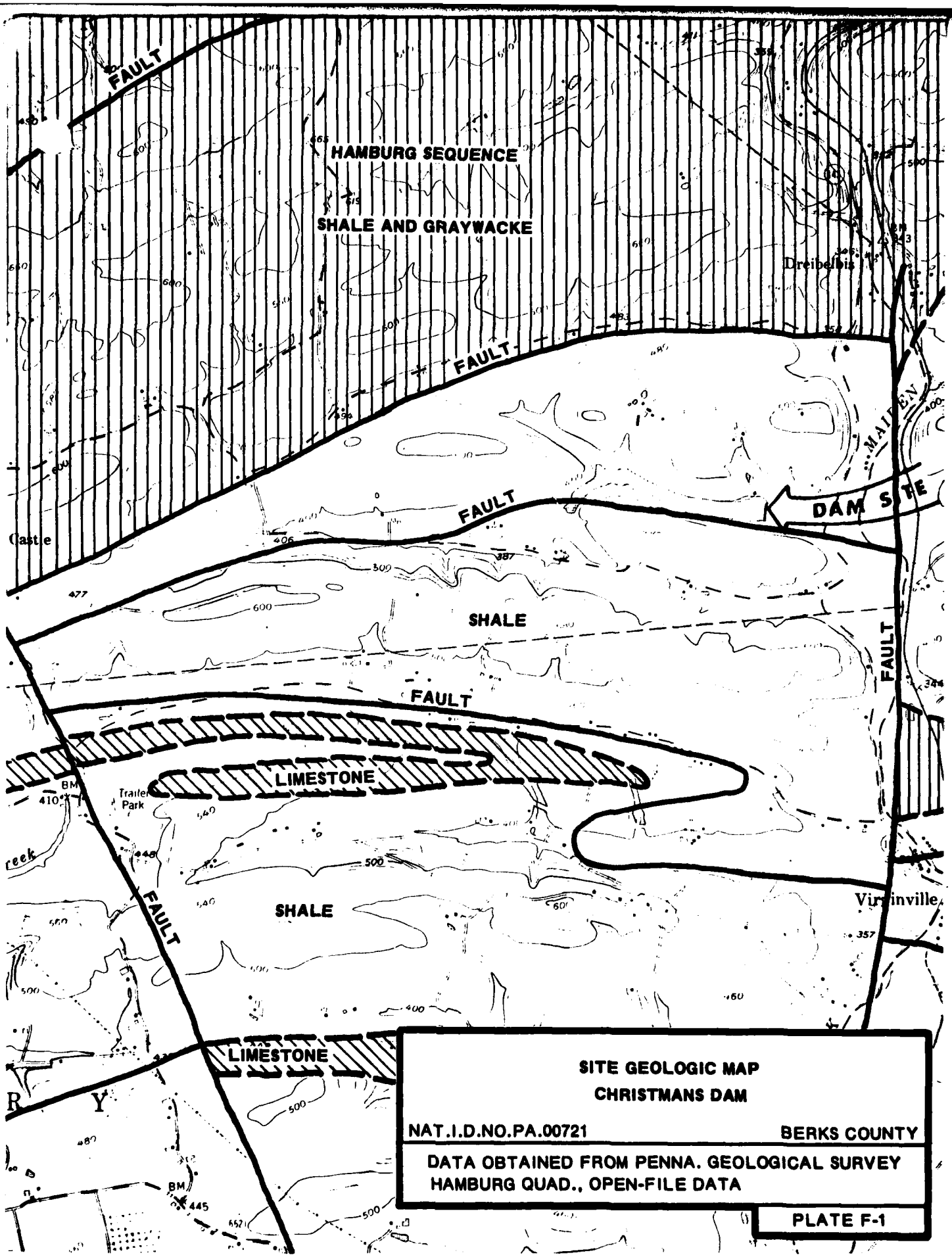
F

SITE GEOLOGY
CHRISTMAN DAM

Christman Dam is located in the Great Valley Section of the Valley and Ridge Physiographic Province. As shown in Plate F-1, the dam is constructed upon shale belonging to a sequence of Ordovician age shale, graywacke and limestone comprising the Hamburg Sequence.

Bedding exposed at the right abutment and spillway channel areas of the dam strikes near east-west (perpendicular to the axis of the dam) and dips 45 degrees to the south. High angle jointing strikes northeast and northwest. Soil cover is relatively thin over the shale bedrock. Seepage could be expected due to the general fractured nature of the bedrock and the overall orientation of the bedding.

This region of Pennsylvania is completely folded and faulted. Several near east-west striking thrust faults occur in the dam area, one of which passes within several hundred feet of the right abutment.



SITE GEOLOGIC MAP
CHRISTMANS DAM

NAT.I.D.NO.PA.00721 **BERKS COUNTY**

DATA OBTAINED FROM PENNA. GEOLOGICAL SURVEY
HAMBURG QUAD., OPEN-FILE DATA

PLATE F-1